

# Average Total Fertility Rate by Geographic Region (1960-2021)

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## Case Study Outline:

- Title: Average Total Fertility Rate by Geographic Region (1960-2021)
- Question: What was the Average Total Fertility Rate by Geographic Region for the last 50 years?
- Dataset: World Bank

## Install required packages

```
library(tidyverse) # helps wrangle data

## -- Attaching core tidyverse packages ----- tidyverse 2.0.0 --
## v dplyr      1.1.2      v readr      2.1.4
## v forcats    1.0.0      v stringr   1.5.0
## v ggplot2    3.4.2      v tibble    3.2.1
## v lubridate  1.9.2      v tidyr     1.3.0
## v purrr      1.0.1
## -- Conflicts ----- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()     masks stats::lag()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors

library(lubridate) # helps wrangle date attributes
library(ggplot2)   # helps visualize data
library(readxl)
getwd() # displays working directory

## [1] "/Users/bradleycardona/Documents/data_analytics/fertility_rate_case_study"
# set working directory to simplify calls to data
setwd("~/Documents/data_analytics/fertility_rate_case_study/")
```

## Step 1: Collect data

```
fertility_rates <- read_xls("fertility_rates.xls")
head(fertility_rates)

## # A tibble: 6 x 67
##   `Country Name` `Country Code` `Indicator Name` `Indicator Code` `1960` `1961`
##   <chr>          <chr>         <chr>           <chr>           <dbl> <dbl>
## 1 Aruba          ABW           Fertility rate,~ SP.DYN.TFRT.IN    4.82  4.66
## 2 Africa Eastern~ AFE           Fertility rate,~ SP.DYN.TFRT.IN    6.72  6.74
## 3 Afghanistan    AFG           Fertility rate,~ SP.DYN.TFRT.IN    7.28  7.28
## 4 Africa Western~ AFW           Fertility rate,~ SP.DYN.TFRT.IN    6.46  6.47
## 5 Angola          AGO           Fertility rate,~ SP.DYN.TFRT.IN    6.71  6.79
## 6 Albania         ALB           Fertility rate,~ SP.DYN.TFRT.IN    6.46  6.35
## # i 61 more variables: `1962` <dbl>, `1963` <dbl>, `1964` <dbl>, `1965` <dbl>,
## #   `1966` <dbl>, `1967` <dbl>, `1968` <dbl>, `1969` <dbl>, `1970` <dbl>,
```

```
## # `1971` <dbl>, `1972` <dbl>, `1973` <dbl>, `1974` <dbl>, `1975` <dbl>,
## # `1976` <dbl>, `1977` <dbl>, `1978` <dbl>, `1979` <dbl>, `1980` <dbl>,
## # `1981` <dbl>, `1982` <dbl>, `1983` <dbl>, `1984` <dbl>, `1985` <dbl>,
## # `1986` <dbl>, `1987` <dbl>, `1988` <dbl>, `1989` <dbl>, `1990` <dbl>,
## # `1991` <dbl>, `1992` <dbl>, `1993` <dbl>, `1994` <dbl>, `1995` <dbl>, ...
```

## Step 2: Wrangle data, look for any incongruencies

```
colnames(fertility_rates) # Column names
```

```
## [1] "Country Name" "Country Code" "Indicator Name" "Indicator Code"
## [5] "1960" "1961" "1962" "1963"
## [9] "1964" "1965" "1966" "1967"
## [13] "1968" "1969" "1970" "1971"
## [17] "1972" "1973" "1974" "1975"
## [21] "1976" "1977" "1978" "1979"
## [25] "1980" "1981" "1982" "1983"
## [29] "1984" "1985" "1986" "1987"
## [33] "1988" "1989" "1990" "1991"
## [37] "1992" "1993" "1994" "1995"
## [41] "1996" "1997" "1998" "1999"
## [45] "2000" "2001" "2002" "2003"
## [49] "2004" "2005" "2006" "2007"
## [53] "2008" "2009" "2010" "2011"
## [57] "2012" "2013" "2014" "2015"
## [61] "2016" "2017" "2018" "2019"
## [65] "2020" "2021" "2022"
```

```
nrow(fertility_rates) # Number of rows
```

```
## [1] 266
```

```
dim(fertility_rates) # Dimensionss
```

```
## [1] 266 67
```

```
head(fertility_rates) # First 6 rows of data frame
```

```
## # A tibble: 6 x 67
##   `Country Name` `Country Code` `Indicator Name` `Indicator Code` `1960` `1961`
##   <chr>         <chr>         <chr>         <chr>         <dbl> <dbl>
## 1 Aruba        ABW          Fertility rate,~ SP.DYN.TFRT.IN    4.82    4.66
## 2 Africa Eastern~ AFE          Fertility rate,~ SP.DYN.TFRT.IN    6.72    6.74
## 3 Afghanistan  AFG          Fertility rate,~ SP.DYN.TFRT.IN    7.28    7.28
## 4 Africa Western~ AFW          Fertility rate,~ SP.DYN.TFRT.IN    6.46    6.47
## 5 Angola        AGO          Fertility rate,~ SP.DYN.TFRT.IN    6.71    6.79
## 6 Albania       ALB          Fertility rate,~ SP.DYN.TFRT.IN    6.46    6.35
## # i 61 more variables: `1962` <dbl>, `1963` <dbl>, `1964` <dbl>, `1965` <dbl>,
## # `1966` <dbl>, `1967` <dbl>, `1968` <dbl>, `1969` <dbl>, `1970` <dbl>,
## # `1971` <dbl>, `1972` <dbl>, `1973` <dbl>, `1974` <dbl>, `1975` <dbl>,
## # `1976` <dbl>, `1977` <dbl>, `1978` <dbl>, `1979` <dbl>, `1980` <dbl>,
## # `1981` <dbl>, `1982` <dbl>, `1983` <dbl>, `1984` <dbl>, `1985` <dbl>,
## # `1986` <dbl>, `1987` <dbl>, `1988` <dbl>, `1989` <dbl>, `1990` <dbl>,
## # `1991` <dbl>, `1992` <dbl>, `1993` <dbl>, `1994` <dbl>, `1995` <dbl>, ...
```

```
str(fertility_rates) # Columns and respective data types (numeric, character, etc)
```

```
## tibble [266 x 67] (S3: tbl_df/tbl/data.frame)
## $ Country Name : chr [1:266] "Aruba" "Africa Eastern and Southern" "Afghanistan" "Africa Western"
## $ Country Code : chr [1:266] "ABW" "AFE" "AFG" "AFW" ...
## $ Indicator Name: chr [1:266] "Fertility rate, total (births per woman)" "Fertility rate, total
```

```

## $ Indicator Code: chr [1:266] "SP.DYN.TFRT.IN" "SP.DYN.TFRT.IN" "SP.DYN.TFRT.IN" "SP.DYN.TFRT.IN"
## $ 1960 : num [1:266] 4.82 6.72 7.28 6.46 6.71 ...
## $ 1961 : num [1:266] 4.66 6.74 7.28 6.47 6.79 ...
## $ 1962 : num [1:266] 4.47 6.76 7.29 6.49 6.87 ...
## $ 1963 : num [1:266] 4.27 6.78 7.3 6.51 6.95 ...
## $ 1964 : num [1:266] 4.06 6.79 7.3 6.53 7.04 ...
## $ 1965 : num [1:266] 3.84 6.8 7.3 6.54 7.12 ...
## $ 1966 : num [1:266] 3.62 6.81 7.32 6.56 7.19 ...
## $ 1967 : num [1:266] 3.42 6.82 7.34 6.59 7.27 ...
## $ 1968 : num [1:266] 3.23 6.83 7.36 6.61 7.33 ...
## $ 1969 : num [1:266] 3.05 6.83 7.39 6.64 7.39 ...
## $ 1970 : num [1:266] 2.91 6.84 7.4 6.66 7.43 ...
## $ 1971 : num [1:266] 2.79 6.84 7.43 6.7 7.47 ...
## $ 1972 : num [1:266] 2.69 6.84 7.45 6.73 7.49 ...
## $ 1973 : num [1:266] 2.61 6.83 7.49 6.76 7.5 ...
## $ 1974 : num [1:266] 2.55 6.82 7.53 6.8 7.5 ...
## $ 1975 : num [1:266] 2.51 6.81 7.54 6.84 7.49 ...
## $ 1976 : num [1:266] 2.47 6.79 7.56 6.86 7.49 ...
## $ 1977 : num [1:266] 2.45 6.77 7.59 6.9 7.47 ...
## $ 1978 : num [1:266] 2.42 6.75 7.6 6.92 7.47 ...
## $ 1979 : num [1:266] 2.41 6.73 7.61 6.91 7.46 ...
## $ 1980 : num [1:266] 2.39 6.7 7.59 6.9 7.46 ...
## $ 1981 : num [1:266] 2.38 6.67 7.57 6.88 7.46 ...
## $ 1982 : num [1:266] 2.36 6.64 7.55 6.86 7.46 ...
## $ 1983 : num [1:266] 2.35 6.6 7.54 6.83 7.46 ...
## $ 1984 : num [1:266] 2.34 6.57 7.51 6.78 7.46 ...
## $ 1985 : num [1:266] 2.33 6.51 7.52 6.73 7.45 ...
## $ 1986 : num [1:266] 2.32 6.46 7.52 6.68 7.43 ...
## $ 1987 : num [1:266] 2.31 6.42 7.53 6.64 7.41 ...
## $ 1988 : num [1:266] 2.29 6.34 7.53 6.6 7.37 ...
## $ 1989 : num [1:266] 2.27 6.26 7.53 6.57 7.33 ...
## $ 1990 : num [1:266] 2.3 6.17 7.57 6.52 7.27 ...
## $ 1991 : num [1:266] 2.31 6.1 7.61 6.47 7.21 ...
## $ 1992 : num [1:266] 2.28 6.03 7.67 6.42 7.14 ...
## $ 1993 : num [1:266] 2.23 5.96 7.72 6.36 7.07 ...
## $ 1994 : num [1:266] 2.12 5.9 7.72 6.3 6.99 ...
## $ 1995 : num [1:266] 2.19 5.84 7.71 6.24 6.92 ...
## $ 1996 : num [1:266] 2.15 5.77 7.71 6.17 6.85 ...
## $ 1997 : num [1:266] 2.14 5.7 7.67 6.1 6.79 ...
## $ 1998 : num [1:266] 1.96 5.64 7.64 6.04 6.73 ...
## $ 1999 : num [1:266] 1.87 5.59 7.6 6.03 6.68 ...
## $ 2000 : num [1:266] 1.9 5.52 7.53 6.02 6.64 ...
## $ 2001 : num [1:266] 1.83 5.48 7.45 6 6.6 ...
## $ 2002 : num [1:266] 1.76 5.43 7.34 5.97 6.57 ...
## $ 2003 : num [1:266] 1.75 5.38 7.22 5.93 6.53 ...
## $ 2004 : num [1:266] 1.68 5.34 7.07 5.89 6.5 ...
## $ 2005 : num [1:266] 1.78 5.31 6.91 5.86 6.46 ...
## $ 2006 : num [1:266] 1.91 5.27 6.72 5.85 6.42 ...
## $ 2007 : num [1:266] 1.93 5.22 6.53 5.82 6.37 ...
## $ 2008 : num [1:266] 1.94 5.19 6.38 5.79 6.32 ...
## $ 2009 : num [1:266] 1.92 5.12 6.24 5.75 6.26 ...
## $ 2010 : num [1:266] 1.94 5.04 6.1 5.7 6.19 ...
## $ 2011 : num [1:266] 1.96 4.96 5.96 5.65 6.12 ...
## $ 2012 : num [1:266] 2.03 4.88 5.83 5.58 6.04 ...
## $ 2013 : num [1:266] 2.12 4.81 5.7 5.51 5.95 ...
## $ 2014 : num [1:266] 2.15 4.74 5.56 5.44 5.86 ...
## $ 2015 : num [1:266] 1.97 4.68 5.41 5.39 5.77 ...
## $ 2016 : num [1:266] 1.95 4.62 5.26 5.33 5.69 ...

```

```
## $ 2017      : num [1:266] 1.84 4.57 5.13 5.26 5.6 ...
## $ 2018      : num [1:266] 1.59 4.53 5 5.19 5.52 ...
## $ 2019      : num [1:266] 1.49 4.48 4.87 5.12 5.44 ...
## $ 2020      : num [1:266] 1.32 4.42 4.75 5.05 5.37 ...
## $ 2021      : num [1:266] 1.18 4.35 4.64 4.98 5.3 ...
## $ 2022      : logi [1:266] NA NA NA NA NA NA ...
```

```
summary(fertility_rates) # Statistical summary of data. Mainly for numerics
```

```
## Country Name      Country Code      Indicator Name      Indicator Code
## Length:266        Length:266        Length:266        Length:266
## Class :character   Class :character   Class :character   Class :character
## Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##      1960      1961      1962      1963
## Min.   :1.940   Min.   :1.940   Min.   :1.790   Min.   :1.820
## 1st Qu.:4.240   1st Qu.:4.082   1st Qu.:4.190   1st Qu.:4.160
## Median :6.078   Median :6.083   Median :6.085   Median :6.147
## Mean   :5.444   Mean   :5.423   Mean   :5.456   Mean   :5.488
## 3rd Qu.:6.721   3rd Qu.:6.725   3rd Qu.:6.747   3rd Qu.:6.771
## Max.   :8.234   Max.   :8.266   Max.   :8.285   Max.   :8.309
## NA's   :13      NA's   :14      NA's   :13      NA's   :14
##      1964      1965      1966      1967
## Min.   :1.790   Min.   :1.740   Min.   :1.580   Min.   :1.800
## 1st Qu.:4.059   1st Qu.:3.842   1st Qu.:3.709   1st Qu.:3.637
## Median :6.019   Median :5.960   Median :5.907   Median :5.825
## Mean   :5.426   Mean   :5.381   Mean   :5.323   Mean   :5.269
## 3rd Qu.:6.734   3rd Qu.:6.733   3rd Qu.:6.707   3rd Qu.:6.683
## Max.   :8.330   Max.   :8.344   Max.   :8.356   Max.   :8.340
## NA's   :13      NA's   :13      NA's   :13      NA's   :13
##      1968      1969      1970      1971
## Min.   :1.830   Min.   :1.870   Min.   :1.823   Min.   :1.680
## 1st Qu.:3.460   1st Qu.:3.284   1st Qu.:3.188   1st Qu.:3.144
## Median :5.788   Median :5.738   Median :5.636   Median :5.534
## Mean   :5.227   Mean   :5.173   Mean   :5.115   Mean   :5.057
## 3rd Qu.:6.682   3rd Qu.:6.679   3rd Qu.:6.680   3rd Qu.:6.654
## Max.   :8.315   Max.   :8.264   Max.   :8.238   Max.   :8.264
## NA's   :13      NA's   :13      NA's   :12      NA's   :12
##      1972      1973      1974      1975
## Min.   :1.580   Min.   :1.490   Min.   :1.510   Min.   :1.450
## 1st Qu.:3.060   1st Qu.:2.933   1st Qu.:2.889   1st Qu.:2.760
## Median :5.314   Median :5.252   Median :5.086   Median :4.975
## Mean   :4.987   Mean   :4.903   Mean   :4.831   Mean   :4.742
## 3rd Qu.:6.599   3rd Qu.:6.630   3rd Qu.:6.608   3rd Qu.:6.586
## Max.   :8.299   Max.   :8.304   Max.   :8.335   Max.   :8.401
## NA's   :12      NA's   :12      NA's   :12      NA's   :11
##      1976      1977      1978      1979
## Min.   :1.450   Min.   :1.400   Min.   :1.380   Min.   :1.380
## 1st Qu.:2.731   1st Qu.:2.659   1st Qu.:2.577   1st Qu.:2.554
## Median :4.810   Median :4.706   Median :4.534   Median :4.493
## Mean   :4.678   Mean   :4.610   Mean   :4.555   Mean   :4.522
## 3rd Qu.:6.554   3rd Qu.:6.512   3rd Qu.:6.474   3rd Qu.:6.463
## Max.   :8.444   Max.   :8.504   Max.   :8.520   Max.   :8.671
## NA's   :10      NA's   :11      NA's   :11      NA's   :11
##      1980      1981      1982      1983
## Min.   :1.440   Min.   :1.430   Min.   :1.410   Min.   :1.330
```

##	1st Qu.:2.471	1st Qu.:2.423	1st Qu.:2.384	1st Qu.:2.373
##	Median :4.426	Median :4.314	Median :4.216	Median :4.095
##	Mean :4.479	Mean :4.425	Mean :4.381	Mean :4.326
##	3rd Qu.:6.399	3rd Qu.:6.375	3rd Qu.:6.371	3rd Qu.:6.303
##	Max. :8.710	Max. :8.752	Max. :8.793	Max. :8.828
##	NA's :11	NA's :11	NA's :10	NA's :11
##	1984	1985	1986	1987
##	Min. :1.290	Min. :1.370	Min. :1.350	Min. :1.311
##	1st Qu.:2.340	1st Qu.:2.324	1st Qu.:2.321	1st Qu.:2.288
##	Median :4.014	Median :3.959	Median :3.962	Median :3.788
##	Mean :4.270	Mean :4.216	Mean :4.164	Mean :4.103
##	3rd Qu.:6.229	3rd Qu.:6.138	3rd Qu.:6.018	3rd Qu.:5.856
##	Max. :8.853	Max. :8.864	Max. :8.858	Max. :8.833
##	NA's :11	NA's :11	NA's :11	NA's :10
##	1988	1989	1990	1991
##	Min. :1.360	Min. :1.296	Min. :1.272	Min. :1.281
##	1st Qu.:2.280	1st Qu.:2.244	1st Qu.:2.304	1st Qu.:2.187
##	Median :3.711	Median :3.583	Median :3.471	Median :3.402
##	Mean :4.050	Mean :3.983	Mean :3.931	Mean :3.853
##	3rd Qu.:5.798	3rd Qu.:5.692	3rd Qu.:5.604	3rd Qu.:5.474
##	Max. :8.786	Max. :8.713	Max. :8.606	Max. :8.459
##	NA's :11	NA's :11	NA's :9	NA's :10
##	1992	1993	1994	1995
##	Min. :1.290	Min. :1.250	Min. :1.190	Min. :1.160
##	1st Qu.:2.120	1st Qu.:2.034	1st Qu.:1.987	1st Qu.:1.967
##	Median :3.318	Median :3.208	Median :3.121	Median :3.072
##	Mean :3.776	Mean :3.699	Mean :3.623	Mean :3.543
##	3rd Qu.:5.314	3rd Qu.:5.203	3rd Qu.:5.046	3rd Qu.:4.884
##	Max. :8.272	Max. :8.048	Max. :7.989	Max. :7.962
##	NA's :9	NA's :10	NA's :10	NA's :9
##	1996	1997	1998	1999
##	Min. :1.140	Min. :1.090	Min. :1.016	Min. :0.981
##	1st Qu.:1.931	1st Qu.:1.896	1st Qu.:1.860	1st Qu.:1.817
##	Median :3.014	Median :2.940	Median :2.815	Median :2.767
##	Mean :3.476	Mean :3.408	Mean :3.339	Mean :3.288
##	3rd Qu.:4.771	3rd Qu.:4.660	3rd Qu.:4.576	3rd Qu.:4.516
##	Max. :7.985	Max. :7.965	Max. :7.817	Max. :7.752
##	NA's :10	NA's :9	NA's :9	NA's :9
##	2000	2001	2002	2003
##	Min. :0.912	Min. :0.840	Min. :0.800	Min. :0.792
##	1st Qu.:1.855	1st Qu.:1.800	1st Qu.:1.790	1st Qu.:1.786
##	Median :2.716	Median :2.667	Median :2.623	Median :2.583
##	Mean :3.235	Mean :3.182	Mean :3.136	Mean :3.095
##	3rd Qu.:4.434	3rd Qu.:4.375	3rd Qu.:4.304	3rd Qu.:4.234
##	Max. :7.732	Max. :7.695	Max. :7.671	Max. :7.654
##	NA's :7	NA's :8	NA's :8	NA's :8
##	2004	2005	2006	2007
##	Min. :0.800	Min. :0.834	Min. :0.874	Min. :0.918
##	1st Qu.:1.781	1st Qu.:1.786	1st Qu.:1.793	1st Qu.:1.823
##	Median :2.582	Median :2.552	Median :2.503	Median :2.510
##	Mean :3.068	Mean :3.033	Mean :3.007	Mean :2.991
##	3rd Qu.:4.129	3rd Qu.:3.983	3rd Qu.:3.850	3rd Qu.:3.863
##	Max. :7.634	Max. :7.615	Max. :7.579	Max. :7.559
##	NA's :8	NA's :7	NA's :7	NA's :7
##	2008	2009	2010	2011
##	Min. :0.947	Min. :0.986	Min. :1.042	Min. :1.115
##	1st Qu.:1.838	1st Qu.:1.823	1st Qu.:1.802	1st Qu.:1.781
##	Median :2.481	Median :2.437	Median :2.397	Median :2.334

```
## Mean :2.983 Mean :2.957 Mean :2.924 Mean :2.895
## 3rd Qu.:3.877 3rd Qu.:3.865 3rd Qu.:3.880 3rd Qu.:3.836
## Max. :7.539 Max. :7.513 Max. :7.485 Max. :7.449
## NA's :7 NA's :7 NA's :7 NA's :8
## 2012 2013 2014 2015
## Min. :1.103 Min. :1.080 Min. :1.205 Min. :1.186
## 1st Qu.:1.792 1st Qu.:1.750 1st Qu.:1.751 1st Qu.:1.734
## Median :2.312 Median :2.328 Median :2.300 Median :2.260
## Mean :2.868 Mean :2.835 Mean :2.813 Mean :2.775
## 3rd Qu.:3.753 3rd Qu.:3.688 3rd Qu.:3.632 3rd Qu.:3.560
## Max. :7.400 Max. :7.344 Max. :7.279 Max. :7.211
## NA's :6 NA's :8 NA's :8 NA's :7
## 2016 2017 2018 2019
## Min. :0.987 Min. :0.872 Min. :0.917 Min. :0.918
## 1st Qu.:1.725 1st Qu.:1.693 1st Qu.:1.648 1st Qu.:1.612
## Median :2.245 Median :2.211 Median :2.175 Median :2.139
## Mean :2.742 Mean :2.694 Mean :2.653 Mean :2.611
## 3rd Qu.:3.492 3rd Qu.:3.432 3rd Qu.:3.403 3rd Qu.:3.333
## Max. :7.141 Max. :7.084 Max. :7.023 Max. :6.961
## NA's :8 NA's :8 NA's :8 NA's :8
## 2020 2021 2022
## Min. :0.837 Min. :0.772 Mode:logical
## 1st Qu.:1.572 1st Qu.:1.583 NA's:266
## Median :2.103 Median :2.088
## Mean :2.560 Mean :2.542
## 3rd Qu.:3.271 3rd Qu.:3.288
## Max. :6.892 Max. :6.820
## NA's :7 NA's :8
```

```
# delete two columns: "Indicator Name" and "Indicator Code"
fertility_rates <- fertility_rates %>%
  select(-c("Indicator Name", "Indicator Code"))
```

### Step 3: Clean up data and prepare for analysis

Inspect the new table that has been created

```
colnames(fertility_rates) # Column names
```

```
## [1] "Country Name" "Country Code" "1960" "1961" "1962"
## [6] "1963" "1964" "1965" "1966" "1967"
## [11] "1968" "1969" "1970" "1971" "1972"
## [16] "1973" "1974" "1975" "1976" "1977"
## [21] "1978" "1979" "1980" "1981" "1982"
## [26] "1983" "1984" "1985" "1986" "1987"
## [31] "1988" "1989" "1990" "1991" "1992"
## [36] "1993" "1994" "1995" "1996" "1997"
## [41] "1998" "1999" "2000" "2001" "2002"
## [46] "2003" "2004" "2005" "2006" "2007"
## [51] "2008" "2009" "2010" "2011" "2012"
## [56] "2013" "2014" "2015" "2016" "2017"
## [61] "2018" "2019" "2020" "2021" "2022"
```

```
nrow(fertility_rates) # Number of rows
```

```
## [1] 266
```

```
dim(fertility_rates) # Dimensions
```

```
## [1] 266 65
```

```
head(fertility_rates) # First 6 rows of data frame
```

```
## # A tibble: 6 x 65
##   `Country Name` `Country Code` `1960` `1961` `1962` `1963` `1964` `1965` `1966`
##   <chr>          <chr>          <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
## 1 Aruba          ABW              4.82  4.66  4.47  4.27  4.06  3.84  3.62
## 2 Africa Easter~ AFE              6.72  6.74  6.76  6.78  6.79  6.80  6.81
## 3 Afghanistan   AFG              7.28  7.28  7.29  7.30  7.30  7.30  7.32
## 4 Africa Wester~ AFW              6.46  6.47  6.49  6.51  6.53  6.54  6.56
## 5 Angola         AGO              6.71  6.79  6.87  6.95  7.04  7.12  7.19
## 6 Albania        ALB              6.46  6.35  6.21  6.05  5.85  5.62  5.46
## # i 56 more variables: `1967` <dbl>, `1968` <dbl>, `1969` <dbl>, `1970` <dbl>,
## #   `1971` <dbl>, `1972` <dbl>, `1973` <dbl>, `1974` <dbl>, `1975` <dbl>,
## #   `1976` <dbl>, `1977` <dbl>, `1978` <dbl>, `1979` <dbl>, `1980` <dbl>,
## #   `1981` <dbl>, `1982` <dbl>, `1983` <dbl>, `1984` <dbl>, `1985` <dbl>,
## #   `1986` <dbl>, `1987` <dbl>, `1988` <dbl>, `1989` <dbl>, `1990` <dbl>,
## #   `1991` <dbl>, `1992` <dbl>, `1993` <dbl>, `1994` <dbl>, `1995` <dbl>,
## #   `1996` <dbl>, `1997` <dbl>, `1998` <dbl>, `1999` <dbl>, `2000` <dbl>, ...
```

```
str(fertility_rates) # Columns and respective data types (numeric, character, etc)
```

```
## tibble [266 x 65] (S3: tbl_df/tbl/data.frame)
## $ Country Name: chr [1:266] "Aruba" "Africa Eastern and Southern" "Afghanistan" "Africa Western
## $ Country Code: chr [1:266] "ABW" "AFE" "AFG" "AFW" ...
## $ 1960 : num [1:266] 4.82 6.72 7.28 6.46 6.71 ...
## $ 1961 : num [1:266] 4.66 6.74 7.28 6.47 6.79 ...
## $ 1962 : num [1:266] 4.47 6.76 7.29 6.49 6.87 ...
## $ 1963 : num [1:266] 4.27 6.78 7.3 6.51 6.95 ...
## $ 1964 : num [1:266] 4.06 6.79 7.3 6.53 7.04 ...
## $ 1965 : num [1:266] 3.84 6.8 7.3 6.54 7.12 ...
## $ 1966 : num [1:266] 3.62 6.81 7.32 6.56 7.19 ...
## $ 1967 : num [1:266] 3.42 6.82 7.34 6.59 7.27 ...
## $ 1968 : num [1:266] 3.23 6.83 7.36 6.61 7.33 ...
## $ 1969 : num [1:266] 3.05 6.83 7.39 6.64 7.39 ...
## $ 1970 : num [1:266] 2.91 6.84 7.4 6.66 7.43 ...
## $ 1971 : num [1:266] 2.79 6.84 7.43 6.7 7.47 ...
## $ 1972 : num [1:266] 2.69 6.84 7.45 6.73 7.49 ...
## $ 1973 : num [1:266] 2.61 6.83 7.49 6.76 7.5 ...
## $ 1974 : num [1:266] 2.55 6.82 7.53 6.8 7.5 ...
## $ 1975 : num [1:266] 2.51 6.81 7.54 6.84 7.49 ...
## $ 1976 : num [1:266] 2.47 6.79 7.56 6.86 7.49 ...
## $ 1977 : num [1:266] 2.45 6.77 7.59 6.9 7.47 ...
## $ 1978 : num [1:266] 2.42 6.75 7.6 6.92 7.47 ...
## $ 1979 : num [1:266] 2.41 6.73 7.61 6.91 7.46 ...
## $ 1980 : num [1:266] 2.39 6.7 7.59 6.9 7.46 ...
## $ 1981 : num [1:266] 2.38 6.67 7.57 6.88 7.46 ...
## $ 1982 : num [1:266] 2.36 6.64 7.55 6.86 7.46 ...
## $ 1983 : num [1:266] 2.35 6.6 7.54 6.83 7.46 ...
## $ 1984 : num [1:266] 2.34 6.57 7.51 6.78 7.46 ...
## $ 1985 : num [1:266] 2.33 6.51 7.52 6.73 7.45 ...
## $ 1986 : num [1:266] 2.32 6.46 7.52 6.68 7.43 ...
## $ 1987 : num [1:266] 2.31 6.42 7.53 6.64 7.41 ...
## $ 1988 : num [1:266] 2.29 6.34 7.53 6.6 7.37 ...
## $ 1989 : num [1:266] 2.27 6.26 7.53 6.57 7.33 ...
## $ 1990 : num [1:266] 2.3 6.17 7.57 6.52 7.27 ...
## $ 1991 : num [1:266] 2.31 6.1 7.61 6.47 7.21 ...
## $ 1992 : num [1:266] 2.28 6.03 7.67 6.42 7.14 ...
## $ 1993 : num [1:266] 2.23 5.96 7.72 6.36 7.07 ...
## $ 1994 : num [1:266] 2.12 5.9 7.72 6.3 6.99 ...
```

```
## $ 1995      : num [1:266] 2.19 5.84 7.71 6.24 6.92 ...
## $ 1996      : num [1:266] 2.15 5.77 7.71 6.17 6.85 ...
## $ 1997      : num [1:266] 2.14 5.7 7.67 6.1 6.79 ...
## $ 1998      : num [1:266] 1.96 5.64 7.64 6.04 6.73 ...
## $ 1999      : num [1:266] 1.87 5.59 7.6 6.03 6.68 ...
## $ 2000      : num [1:266] 1.9 5.52 7.53 6.02 6.64 ...
## $ 2001      : num [1:266] 1.83 5.48 7.45 6 6.6 ...
## $ 2002      : num [1:266] 1.76 5.43 7.34 5.97 6.57 ...
## $ 2003      : num [1:266] 1.75 5.38 7.22 5.93 6.53 ...
## $ 2004      : num [1:266] 1.68 5.34 7.07 5.89 6.5 ...
## $ 2005      : num [1:266] 1.78 5.31 6.91 5.86 6.46 ...
## $ 2006      : num [1:266] 1.91 5.27 6.72 5.85 6.42 ...
## $ 2007      : num [1:266] 1.93 5.22 6.53 5.82 6.37 ...
## $ 2008      : num [1:266] 1.94 5.19 6.38 5.79 6.32 ...
## $ 2009      : num [1:266] 1.92 5.12 6.24 5.75 6.26 ...
## $ 2010      : num [1:266] 1.94 5.04 6.1 5.7 6.19 ...
## $ 2011      : num [1:266] 1.96 4.96 5.96 5.65 6.12 ...
## $ 2012      : num [1:266] 2.03 4.88 5.83 5.58 6.04 ...
## $ 2013      : num [1:266] 2.12 4.81 5.7 5.51 5.95 ...
## $ 2014      : num [1:266] 2.15 4.74 5.56 5.44 5.86 ...
## $ 2015      : num [1:266] 1.97 4.68 5.41 5.39 5.77 ...
## $ 2016      : num [1:266] 1.95 4.62 5.26 5.33 5.69 ...
## $ 2017      : num [1:266] 1.84 4.57 5.13 5.26 5.6 ...
## $ 2018      : num [1:266] 1.59 4.53 5 5.19 5.52 ...
## $ 2019      : num [1:266] 1.49 4.48 4.87 5.12 5.44 ...
## $ 2020      : num [1:266] 1.32 4.42 4.75 5.05 5.37 ...
## $ 2021      : num [1:266] 1.18 4.35 4.64 4.98 5.3 ...
## $ 2022      : logi [1:266] NA NA NA NA NA NA ...
```

```
summary(fertility_rates) # Statistical summary of data. Mainly for numerics
```

```
## Country Name      Country Code      1960      1961
## Length:266      Length:266      Min.   :1.940  Min.   :1.940
## Class :character  Class :character  1st Qu.:4.240  1st Qu.:4.082
## Mode  :character  Mode  :character  Median :6.078  Median :6.083
##                  Mean   :5.444  Mean   :5.423
##                  3rd Qu.:6.721  3rd Qu.:6.725
##                  Max.   :8.234  Max.   :8.266
##                  NA's   :13     NA's   :14
##      1962      1963      1964      1965
## Min.   :1.790  Min.   :1.820  Min.   :1.790  Min.   :1.740
## 1st Qu.:4.190  1st Qu.:4.160  1st Qu.:4.059  1st Qu.:3.842
## Median :6.085  Median :6.147  Median :6.019  Median :5.960
## Mean   :5.456  Mean   :5.488  Mean   :5.426  Mean   :5.381
## 3rd Qu.:6.747  3rd Qu.:6.771  3rd Qu.:6.734  3rd Qu.:6.733
## Max.   :8.285  Max.   :8.309  Max.   :8.330  Max.   :8.344
## NA's   :13     NA's   :14     NA's   :13     NA's   :13
##      1966      1967      1968      1969
## Min.   :1.580  Min.   :1.800  Min.   :1.830  Min.   :1.870
## 1st Qu.:3.709  1st Qu.:3.637  1st Qu.:3.460  1st Qu.:3.284
## Median :5.907  Median :5.825  Median :5.788  Median :5.738
## Mean   :5.323  Mean   :5.269  Mean   :5.227  Mean   :5.173
## 3rd Qu.:6.707  3rd Qu.:6.683  3rd Qu.:6.682  3rd Qu.:6.679
## Max.   :8.356  Max.   :8.340  Max.   :8.315  Max.   :8.264
## NA's   :13     NA's   :13     NA's   :13     NA's   :13
##      1970      1971      1972      1973
## Min.   :1.823  Min.   :1.680  Min.   :1.580  Min.   :1.490
## 1st Qu.:3.188  1st Qu.:3.144  1st Qu.:3.060  1st Qu.:2.933
## Median :5.636  Median :5.534  Median :5.314  Median :5.252
```



##	Mean	:5.115	Mean	:5.057	Mean	:4.987	Mean	:4.903
##	3rd Qu.:	6.680	3rd Qu.:	6.654	3rd Qu.:	6.599	3rd Qu.:	6.630
##	Max.	:8.238	Max.	:8.264	Max.	:8.299	Max.	:8.304
##	NA's	:12	NA's	:12	NA's	:12	NA's	:12
##	1974		1975		1976		1977	
##	Min.	:1.510	Min.	:1.450	Min.	:1.450	Min.	:1.400
##	1st Qu.:	2.889	1st Qu.:	2.760	1st Qu.:	2.731	1st Qu.:	2.659
##	Median	:5.086	Median	:4.975	Median	:4.810	Median	:4.706
##	Mean	:4.831	Mean	:4.742	Mean	:4.678	Mean	:4.610
##	3rd Qu.:	6.608	3rd Qu.:	6.586	3rd Qu.:	6.554	3rd Qu.:	6.512
##	Max.	:8.335	Max.	:8.401	Max.	:8.444	Max.	:8.504
##	NA's	:12	NA's	:11	NA's	:10	NA's	:11
##	1978		1979		1980		1981	
##	Min.	:1.380	Min.	:1.380	Min.	:1.440	Min.	:1.430
##	1st Qu.:	2.577	1st Qu.:	2.554	1st Qu.:	2.471	1st Qu.:	2.423
##	Median	:4.534	Median	:4.493	Median	:4.426	Median	:4.314
##	Mean	:4.555	Mean	:4.522	Mean	:4.479	Mean	:4.425
##	3rd Qu.:	6.474	3rd Qu.:	6.463	3rd Qu.:	6.399	3rd Qu.:	6.375
##	Max.	:8.520	Max.	:8.671	Max.	:8.710	Max.	:8.752
##	NA's	:11	NA's	:11	NA's	:11	NA's	:11
##	1982		1983		1984		1985	
##	Min.	:1.410	Min.	:1.330	Min.	:1.290	Min.	:1.370
##	1st Qu.:	2.384	1st Qu.:	2.373	1st Qu.:	2.340	1st Qu.:	2.324
##	Median	:4.216	Median	:4.095	Median	:4.014	Median	:3.959
##	Mean	:4.381	Mean	:4.326	Mean	:4.270	Mean	:4.216
##	3rd Qu.:	6.371	3rd Qu.:	6.303	3rd Qu.:	6.229	3rd Qu.:	6.138
##	Max.	:8.793	Max.	:8.828	Max.	:8.853	Max.	:8.864
##	NA's	:10	NA's	:11	NA's	:11	NA's	:11
##	1986		1987		1988		1989	
##	Min.	:1.350	Min.	:1.311	Min.	:1.360	Min.	:1.296
##	1st Qu.:	2.321	1st Qu.:	2.288	1st Qu.:	2.280	1st Qu.:	2.244
##	Median	:3.962	Median	:3.788	Median	:3.711	Median	:3.583
##	Mean	:4.164	Mean	:4.103	Mean	:4.050	Mean	:3.983
##	3rd Qu.:	6.018	3rd Qu.:	5.856	3rd Qu.:	5.798	3rd Qu.:	5.692
##	Max.	:8.858	Max.	:8.833	Max.	:8.786	Max.	:8.713
##	NA's	:11	NA's	:10	NA's	:11	NA's	:11
##	1990		1991		1992		1993	
##	Min.	:1.272	Min.	:1.281	Min.	:1.290	Min.	:1.250
##	1st Qu.:	2.304	1st Qu.:	2.187	1st Qu.:	2.120	1st Qu.:	2.034
##	Median	:3.471	Median	:3.402	Median	:3.318	Median	:3.208
##	Mean	:3.931	Mean	:3.853	Mean	:3.776	Mean	:3.699
##	3rd Qu.:	5.604	3rd Qu.:	5.474	3rd Qu.:	5.314	3rd Qu.:	5.203
##	Max.	:8.606	Max.	:8.459	Max.	:8.272	Max.	:8.048
##	NA's	:9	NA's	:10	NA's	:9	NA's	:10
##	1994		1995		1996		1997	
##	Min.	:1.190	Min.	:1.160	Min.	:1.140	Min.	:1.090
##	1st Qu.:	1.987	1st Qu.:	1.967	1st Qu.:	1.931	1st Qu.:	1.896
##	Median	:3.121	Median	:3.072	Median	:3.014	Median	:2.940
##	Mean	:3.623	Mean	:3.543	Mean	:3.476	Mean	:3.408
##	3rd Qu.:	5.046	3rd Qu.:	4.884	3rd Qu.:	4.771	3rd Qu.:	4.660
##	Max.	:7.989	Max.	:7.962	Max.	:7.985	Max.	:7.965
##	NA's	:10	NA's	:9	NA's	:10	NA's	:9
##	1998		1999		2000		2001	
##	Min.	:1.016	Min.	:0.981	Min.	:0.912	Min.	:0.840
##	1st Qu.:	1.860	1st Qu.:	1.817	1st Qu.:	1.855	1st Qu.:	1.800
##	Median	:2.815	Median	:2.767	Median	:2.716	Median	:2.667
##	Mean	:3.339	Mean	:3.288	Mean	:3.235	Mean	:3.182
##	3rd Qu.:	4.576	3rd Qu.:	4.516	3rd Qu.:	4.434	3rd Qu.:	4.375

```
## Max. :7.817 Max. :7.752 Max. :7.732 Max. :7.695
## NA's :9 NA's :9 NA's :7 NA's :8
## 2002 2003 2004 2005
## Min. :0.800 Min. :0.792 Min. :0.800 Min. :0.834
## 1st Qu.:1.790 1st Qu.:1.786 1st Qu.:1.781 1st Qu.:1.786
## Median :2.623 Median :2.583 Median :2.582 Median :2.552
## Mean :3.136 Mean :3.095 Mean :3.068 Mean :3.033
## 3rd Qu.:4.304 3rd Qu.:4.234 3rd Qu.:4.129 3rd Qu.:3.983
## Max. :7.671 Max. :7.654 Max. :7.634 Max. :7.615
## NA's :8 NA's :8 NA's :8 NA's :7
## 2006 2007 2008 2009
## Min. :0.874 Min. :0.918 Min. :0.947 Min. :0.986
## 1st Qu.:1.793 1st Qu.:1.823 1st Qu.:1.838 1st Qu.:1.823
## Median :2.503 Median :2.510 Median :2.481 Median :2.437
## Mean :3.007 Mean :2.991 Mean :2.983 Mean :2.957
## 3rd Qu.:3.850 3rd Qu.:3.863 3rd Qu.:3.877 3rd Qu.:3.865
## Max. :7.579 Max. :7.559 Max. :7.539 Max. :7.513
## NA's :7 NA's :7 NA's :7 NA's :7
## 2010 2011 2012 2013
## Min. :1.042 Min. :1.115 Min. :1.103 Min. :1.080
## 1st Qu.:1.802 1st Qu.:1.781 1st Qu.:1.792 1st Qu.:1.750
## Median :2.397 Median :2.334 Median :2.312 Median :2.328
## Mean :2.924 Mean :2.895 Mean :2.868 Mean :2.835
## 3rd Qu.:3.880 3rd Qu.:3.836 3rd Qu.:3.753 3rd Qu.:3.688
## Max. :7.485 Max. :7.449 Max. :7.400 Max. :7.344
## NA's :7 NA's :8 NA's :6 NA's :8
## 2014 2015 2016 2017
## Min. :1.205 Min. :1.186 Min. :0.987 Min. :0.872
## 1st Qu.:1.751 1st Qu.:1.734 1st Qu.:1.725 1st Qu.:1.693
## Median :2.300 Median :2.260 Median :2.245 Median :2.211
## Mean :2.813 Mean :2.775 Mean :2.742 Mean :2.694
## 3rd Qu.:3.632 3rd Qu.:3.560 3rd Qu.:3.492 3rd Qu.:3.432
## Max. :7.279 Max. :7.211 Max. :7.141 Max. :7.084
## NA's :8 NA's :7 NA's :8 NA's :8
## 2018 2019 2020 2021 2022
## Min. :0.917 Min. :0.918 Min. :0.837 Min. :0.772 Mode:logical
## 1st Qu.:1.648 1st Qu.:1.612 1st Qu.:1.572 1st Qu.:1.583 NA's:266
## Median :2.175 Median :2.139 Median :2.103 Median :2.088
## Mean :2.653 Mean :2.611 Mean :2.560 Mean :2.542
## 3rd Qu.:3.403 3rd Qu.:3.333 3rd Qu.:3.271 3rd Qu.:3.288
## Max. :7.023 Max. :6.961 Max. :6.892 Max. :6.820
## NA's :8 NA's :8 NA's :7 NA's :8
```

## Step 4: Conduct descriptive analysis

```
summary(fertility_rates$"1960")
```

```
## Min. 1st Qu. Median Mean 3rd Qu. Max. NA's
## 1.940 4.240 6.078 5.444 6.721 8.234 13
```

```
# Compare Average Total Fertility rates in 1960 vs. Average Total Fertility rates in 2021
aggregate(fertility_rates$"1960" ~ fertility_rates$"2021", FUN = mean)
```

```
## fertility_rates$"2021" fertility_rates$"1960"
## 1 0.772000 5.067000
## 2 0.808000 5.949000
## 3 0.907000 4.796000
## 4 1.005000 5.162000
## 5 1.088000 4.933000
```

## 6	1.120000	5.760000
## 7	1.140000	3.620000
## 8	1.160000	2.240000
## 9	1.164000	4.451000
## 10	1.180000	4.820000
## 11	1.190000	2.860000
## 12	1.250000	2.400000
## 13	1.300000	2.755000
## 14	1.321000	3.512000
## 15	1.330000	2.980000
## 16	1.331000	6.248000
## 17	1.340000	2.560000
## 18	1.350000	3.907000
## 19	1.352000	5.580000
## 20	1.380000	2.725000
## 21	1.383908	4.801000
## 22	1.389000	4.818000
## 23	1.390000	4.342500
## 24	1.396865	4.378614
## 25	1.399000	6.967000
## 26	1.410000	6.167000
## 27	1.413000	6.704000
## 28	1.430000	3.811000
## 29	1.442000	4.129000
## 30	1.457000	2.270000
## 31	1.460000	4.719000
## 32	1.480000	2.401500
## 33	1.483000	2.670000
## 34	1.488552	2.897990
## 35	1.489433	4.561606
## 36	1.493000	2.673500
## 37	1.498219	4.531774
## 38	1.504510	2.605864
## 39	1.516846	4.864229
## 40	1.520000	4.159000
## 41	1.520288	2.571186
## 42	1.520442	4.841982
## 43	1.522000	6.359000
## 44	1.531000	7.169000
## 45	1.533000	6.712000
## 46	1.537000	4.697000
## 47	1.544788	3.019437
## 48	1.550000	2.850000
## 49	1.550993	2.491059
## 50	1.560000	2.690000
## 51	1.564000	2.875000
## 52	1.570000	1.940000
## 53	1.575000	4.786000
## 54	1.580000	3.094000
## 55	1.581000	4.202000
## 56	1.589351	3.285589
## 57	1.590000	2.020000
## 58	1.595000	6.866000
## 59	1.600000	3.253500
## 60	1.610000	1.980000
## 61	1.620000	2.676000
## 62	1.626000	5.345000
## 63	1.633000	4.333000

## 64	1.640000	3.155000
## 65	1.640018	3.668255
## 66	1.641000	6.061000
## 67	1.664000	3.654000
## 68	1.664522	5.727913
## 69	1.669000	5.790000
## 70	1.670000	2.170000
## 71	1.692000	7.052500
## 72	1.693061	2.831429
## 73	1.699000	5.888000
## 74	1.700000	3.453000
## 75	1.717000	6.735000
## 76	1.720000	3.175000
## 77	1.750000	3.498000
## 78	1.778000	6.836000
## 79	1.797000	7.286000
## 80	1.800000	2.340000
## 81	1.801000	6.647000
## 82	1.803000	6.520500
## 83	1.806000	3.328000
## 84	1.809000	3.568000
## 85	1.811000	7.152000
## 86	1.820000	4.290000
## 87	1.822000	6.763000
## 88	1.824446	4.970095
## 89	1.830000	2.470000
## 90	1.835001	3.103683
## 91	1.848000	3.012000
## 92	1.852014	5.959449
## 93	1.853283	5.865889
## 94	1.864022	5.945441
## 95	1.883205	3.184230
## 96	1.885000	3.075000
## 97	1.889000	6.383000
## 98	1.896000	6.885000
## 99	1.944000	6.280000
## 100	1.981000	6.784000
## 101	1.990000	5.465000
## 102	2.004000	6.743000
## 103	2.010000	5.972500
## 104	2.020000	6.278000
## 105	2.026000	6.721000
## 106	2.029000	6.030000
## 107	2.031000	5.921000
## 108	2.081000	2.942000
## 109	2.086000	6.942000
## 110	2.091000	5.818000
## 111	2.110000	7.162000
## 112	2.136727	5.219097
## 113	2.151000	5.983000
## 114	2.175000	5.547000
## 115	2.192000	6.941000
## 116	2.211000	6.358000
## 117	2.240930	6.078350
## 118	2.273000	7.555000
## 119	2.273169	4.695876
## 120	2.321000	7.159000
## 121	2.325000	5.844000

## 122	2.328000	7.040000
## 123	2.344000	6.251000
## 124	2.348000	6.608000
## 125	2.350962	6.166562
## 126	2.363000	7.458000
## 127	2.374000	6.159000
## 128	2.384585	5.251170
## 129	2.393171	5.301390
## 130	2.395000	6.955000
## 131	2.397000	6.372000
## 132	2.415000	5.948000
## 133	2.427000	7.626000
## 134	2.462000	7.373000
## 135	2.469000	6.500000
## 136	2.475000	6.461000
## 137	2.496000	6.292000
## 138	2.569000	5.906000
## 139	2.578281	5.983878
## 140	2.618000	6.358000
## 141	2.623000	7.247000
## 142	2.629064	6.950247
## 143	2.655901	5.357909
## 144	2.660823	7.002555
## 145	2.667000	6.590000
## 146	2.670537	7.002555
## 147	2.711000	6.686000
## 148	2.729000	8.234000
## 149	2.747000	7.485000
## 150	2.748000	7.148000
## 151	2.791000	6.628000
## 152	2.804000	6.828000
## 153	2.814000	6.208000
## 154	2.830000	7.669000
## 155	2.837000	6.827000
## 156	2.839000	6.752000
## 157	2.859614	5.069770
## 158	2.889000	7.503000
## 159	2.890000	5.376000
## 160	2.917000	6.794000
## 161	3.000000	3.866000
## 162	3.018000	5.819000
## 163	3.142565	6.934332
## 164	3.149000	6.319000
## 165	3.163000	4.778000
## 166	3.173000	6.613000
## 167	3.186000	6.547000
## 168	3.215000	6.018000
## 169	3.237000	6.885000
## 170	3.241013	6.768236
## 171	3.303000	6.205000
## 172	3.304000	6.553000
## 173	3.320000	4.530000
## 174	3.335000	7.632000
## 175	3.470000	6.800000
## 176	3.491000	5.821000
## 177	3.496000	5.300000
## 178	3.519000	5.269000
## 179	3.563000	6.847000

```
## 180      3.735000      6.863000
## 181      3.795000      7.938000
## 182      3.821000      8.187000
## 183      3.823000      6.242000
## 184      3.843961      6.629390
## 185      3.851000      7.300000
## 186      3.867000      6.483000
## 187      3.917000      7.029000
## 188      3.921027      6.622652
## 189      3.930000      7.646000
## 190      3.978000      6.483500
## 191      3.983000      6.970000
## 192      3.983665      6.640794
## 193      4.005000      5.921000
## 194      4.080936      6.607081
## 195      4.089000      6.391000
## 196      4.159000      6.880000
## 197      4.171000      6.085000
## 198      4.257000      6.717000
## 199      4.266000      5.653000
## 200      4.308000      7.115000
## 201      4.354710      6.724125
## 202      4.359060      5.603609
## 203      4.387000      6.996000
## 204      4.398000      6.354000
## 205      4.399000      6.112000
## 206      4.418000      7.691000
## 207      4.457000      6.647000
## 208      4.463000      5.647000
## 209      4.469000      6.721000
## 210      4.585000      6.936000
## 211      4.601289      6.609096
## 212      4.601463      6.609096
## 213      4.620300      6.702820
## 214      4.643000      7.282000
## 215      4.644000      6.315000
## 216      4.644854      6.414706
## 217      4.684000      6.246000
## 218      4.726000      6.725000
## 219      4.772000      6.248000
## 220      4.844171      6.563645
## 221      4.973000      6.282000
## 222      4.978662      6.458448
## 223      5.078000      7.003000
## 224      5.237000      6.364000
## 225      5.304000      6.708000
## 226      5.956000      7.004000
## 227      5.978000      5.814000
## 228      6.156000      6.080000
## 229      6.255000      6.250000
## 230      6.312000      7.250000
## 231      6.820000      7.530000
```

```
# Compare median fertility rates in 1960 vs. median fertility in 2021
aggregate(fertility_rates$"1960" ~ fertility_rates$"2021", FUN = median)
```

```
##      fertility_rates$"2021" fertility_rates$"1960"
## 1          0.772000          5.067000
## 2          0.808000          5.949000
```

## 3	0.907000	4.796000
## 4	1.005000	5.162000
## 5	1.088000	4.933000
## 6	1.120000	5.760000
## 7	1.140000	3.620000
## 8	1.160000	2.240000
## 9	1.164000	4.451000
## 10	1.180000	4.820000
## 11	1.190000	2.860000
## 12	1.250000	2.400000
## 13	1.300000	2.755000
## 14	1.321000	3.512000
## 15	1.330000	2.980000
## 16	1.331000	6.248000
## 17	1.340000	2.560000
## 18	1.350000	3.907000
## 19	1.352000	5.580000
## 20	1.380000	2.725000
## 21	1.383908	4.801000
## 22	1.389000	4.818000
## 23	1.390000	4.342500
## 24	1.396865	4.378614
## 25	1.399000	6.967000
## 26	1.410000	6.167000
## 27	1.413000	6.704000
## 28	1.430000	3.811000
## 29	1.442000	4.129000
## 30	1.457000	2.270000
## 31	1.460000	4.719000
## 32	1.480000	2.401500
## 33	1.483000	2.670000
## 34	1.488552	2.897990
## 35	1.489433	4.561606
## 36	1.493000	2.673500
## 37	1.498219	4.531774
## 38	1.504510	2.605864
## 39	1.516846	4.864229
## 40	1.520000	4.159000
## 41	1.520288	2.571186
## 42	1.520442	4.841982
## 43	1.522000	6.359000
## 44	1.531000	7.169000
## 45	1.533000	6.712000
## 46	1.537000	4.697000
## 47	1.544788	3.019437
## 48	1.550000	2.850000
## 49	1.550993	2.491059
## 50	1.560000	2.690000
## 51	1.564000	2.875000
## 52	1.570000	1.940000
## 53	1.575000	4.786000
## 54	1.580000	2.370000
## 55	1.581000	4.202000
## 56	1.589351	3.285589
## 57	1.590000	2.020000
## 58	1.595000	6.866000
## 59	1.600000	3.253500
## 60	1.610000	1.980000

## 61	1.620000	2.676000
## 62	1.626000	5.345000
## 63	1.633000	4.333000
## 64	1.640000	3.040000
## 65	1.640018	3.668255
## 66	1.641000	6.061000
## 67	1.664000	3.654000
## 68	1.664522	5.727913
## 69	1.669000	5.790000
## 70	1.670000	2.170000
## 71	1.692000	7.052500
## 72	1.693061	2.831429
## 73	1.699000	5.888000
## 74	1.700000	3.453000
## 75	1.717000	6.735000
## 76	1.720000	3.175000
## 77	1.750000	3.498000
## 78	1.778000	6.836000
## 79	1.797000	7.286000
## 80	1.800000	2.340000
## 81	1.801000	6.647000
## 82	1.803000	6.520500
## 83	1.806000	3.328000
## 84	1.809000	3.568000
## 85	1.811000	7.152000
## 86	1.820000	4.290000
## 87	1.822000	6.763000
## 88	1.824446	4.970095
## 89	1.830000	2.470000
## 90	1.835001	3.103683
## 91	1.848000	3.012000
## 92	1.852014	5.959449
## 93	1.853283	5.865889
## 94	1.864022	5.945441
## 95	1.883205	3.184230
## 96	1.885000	3.075000
## 97	1.889000	6.383000
## 98	1.896000	6.885000
## 99	1.944000	6.280000
## 100	1.981000	6.784000
## 101	1.990000	5.465000
## 102	2.004000	6.743000
## 103	2.010000	5.972500
## 104	2.020000	6.278000
## 105	2.026000	6.721000
## 106	2.029000	6.030000
## 107	2.031000	5.921000
## 108	2.081000	2.942000
## 109	2.086000	6.942000
## 110	2.091000	5.818000
## 111	2.110000	7.162000
## 112	2.136727	5.219097
## 113	2.151000	5.983000
## 114	2.175000	5.547000
## 115	2.192000	6.941000
## 116	2.211000	6.358000
## 117	2.240930	6.078350
## 118	2.273000	7.555000



## 119	2.273169	4.695876
## 120	2.321000	7.159000
## 121	2.325000	5.844000
## 122	2.328000	7.040000
## 123	2.344000	6.251000
## 124	2.348000	6.608000
## 125	2.350962	6.166562
## 126	2.363000	7.458000
## 127	2.374000	6.159000
## 128	2.384585	5.251170
## 129	2.393171	5.301390
## 130	2.395000	6.955000
## 131	2.397000	6.372000
## 132	2.415000	5.948000
## 133	2.427000	7.626000
## 134	2.462000	7.373000
## 135	2.469000	6.500000
## 136	2.475000	6.461000
## 137	2.496000	6.292000
## 138	2.569000	5.906000
## 139	2.578281	5.983878
## 140	2.618000	6.358000
## 141	2.623000	7.247000
## 142	2.629064	6.950247
## 143	2.655901	5.357909
## 144	2.660823	7.002555
## 145	2.667000	6.590000
## 146	2.670537	7.002555
## 147	2.711000	6.686000
## 148	2.729000	8.234000
## 149	2.747000	7.485000
## 150	2.748000	7.148000
## 151	2.791000	6.628000
## 152	2.804000	6.828000
## 153	2.814000	6.208000
## 154	2.830000	7.669000
## 155	2.837000	6.827000
## 156	2.839000	6.752000
## 157	2.859614	5.069770
## 158	2.889000	7.503000
## 159	2.890000	5.376000
## 160	2.917000	6.794000
## 161	3.000000	3.866000
## 162	3.018000	5.819000
## 163	3.142565	6.934332
## 164	3.149000	6.319000
## 165	3.163000	4.778000
## 166	3.173000	6.613000
## 167	3.186000	6.547000
## 168	3.215000	6.018000
## 169	3.237000	6.885000
## 170	3.241013	6.768236
## 171	3.303000	6.205000
## 172	3.304000	6.553000
## 173	3.320000	4.530000
## 174	3.335000	7.632000
## 175	3.470000	6.800000
## 176	3.491000	5.821000

## 177	3.496000	5.300000
## 178	3.519000	5.269000
## 179	3.563000	6.847000
## 180	3.735000	6.863000
## 181	3.795000	7.938000
## 182	3.821000	8.187000
## 183	3.823000	6.242000
## 184	3.843961	6.629390
## 185	3.851000	7.300000
## 186	3.867000	6.483000
## 187	3.917000	7.029000
## 188	3.921027	6.622652
## 189	3.930000	7.646000
## 190	3.978000	6.483500
## 191	3.983000	6.970000
## 192	3.983665	6.640794
## 193	4.005000	5.921000
## 194	4.080936	6.607081
## 195	4.089000	6.391000
## 196	4.159000	6.880000
## 197	4.171000	6.085000
## 198	4.257000	6.717000
## 199	4.266000	5.653000
## 200	4.308000	7.115000
## 201	4.354710	6.724125
## 202	4.359060	5.603609
## 203	4.387000	6.996000
## 204	4.398000	6.354000
## 205	4.399000	6.112000
## 206	4.418000	7.691000
## 207	4.457000	6.647000
## 208	4.463000	5.647000
## 209	4.469000	6.721000
## 210	4.585000	6.936000
## 211	4.601289	6.609096
## 212	4.601463	6.609096
## 213	4.620300	6.702820
## 214	4.643000	7.282000
## 215	4.644000	6.315000
## 216	4.644854	6.414706
## 217	4.684000	6.246000
## 218	4.726000	6.725000
## 219	4.772000	6.248000
## 220	4.844171	6.563645
## 221	4.973000	6.282000
## 222	4.978662	6.458448
## 223	5.078000	7.003000
## 224	5.237000	6.364000
## 225	5.304000	6.708000
## 226	5.956000	7.004000
## 227	5.978000	5.814000
## 228	6.156000	6.080000
## 229	6.255000	6.250000
## 230	6.312000	7.250000
## 231	6.820000	7.530000

```
# Compare maximum fertility rates in 1960 vs. maximum fertility rates in 2021
aggregate(fertility_rates$"1960" ~ fertility_rates$"2021", FUN = max)
```

##	fertility_rates\$"2021"	fertility_rates\$"1960"
## 1	0.772000	5.067000
## 2	0.808000	5.949000
## 3	0.907000	4.796000
## 4	1.005000	5.162000
## 5	1.088000	4.933000
## 6	1.120000	5.760000
## 7	1.140000	3.620000
## 8	1.160000	2.240000
## 9	1.164000	4.451000
## 10	1.180000	4.820000
## 11	1.190000	2.860000
## 12	1.250000	2.400000
## 13	1.300000	3.510000
## 14	1.321000	3.512000
## 15	1.330000	2.980000
## 16	1.331000	6.248000
## 17	1.340000	2.560000
## 18	1.350000	3.907000
## 19	1.352000	5.580000
## 20	1.380000	3.160000
## 21	1.383908	4.801000
## 22	1.389000	4.818000
## 23	1.390000	6.455000
## 24	1.396865	4.378614
## 25	1.399000	6.967000
## 26	1.410000	6.167000
## 27	1.413000	6.704000
## 28	1.430000	3.811000
## 29	1.442000	4.129000
## 30	1.457000	2.270000
## 31	1.460000	6.718000
## 32	1.480000	2.690000
## 33	1.483000	2.670000
## 34	1.488552	2.897990
## 35	1.489433	4.561606
## 36	1.493000	2.827000
## 37	1.498219	4.531774
## 38	1.504510	2.605864
## 39	1.516846	4.864229
## 40	1.520000	5.878000
## 41	1.520288	2.571186
## 42	1.520442	4.841982
## 43	1.522000	6.359000
## 44	1.531000	7.169000
## 45	1.533000	6.712000
## 46	1.537000	4.697000
## 47	1.544788	3.019437
## 48	1.550000	2.850000
## 49	1.550993	2.491059
## 50	1.560000	2.690000
## 51	1.564000	2.875000
## 52	1.570000	1.940000
## 53	1.575000	4.786000
## 54	1.580000	4.602000
## 55	1.581000	4.202000
## 56	1.589351	3.285589
## 57	1.590000	2.020000

## 58	1.595000	6.866000
## 59	1.600000	3.967000
## 60	1.610000	1.980000
## 61	1.620000	3.120000
## 62	1.626000	5.345000
## 63	1.633000	4.333000
## 64	1.640000	4.240000
## 65	1.640018	3.668255
## 66	1.641000	6.061000
## 67	1.664000	3.654000
## 68	1.664522	5.727913
## 69	1.669000	5.790000
## 70	1.670000	2.170000
## 71	1.692000	7.301000
## 72	1.693061	2.831429
## 73	1.699000	5.888000
## 74	1.700000	3.453000
## 75	1.717000	6.735000
## 76	1.720000	3.780000
## 77	1.750000	3.498000
## 78	1.778000	6.836000
## 79	1.797000	7.286000
## 80	1.800000	2.340000
## 81	1.801000	6.647000
## 82	1.803000	6.634000
## 83	1.806000	3.328000
## 84	1.809000	3.568000
## 85	1.811000	7.152000
## 86	1.820000	4.290000
## 87	1.822000	6.763000
## 88	1.824446	4.970095
## 89	1.830000	2.850000
## 90	1.835001	3.103683
## 91	1.848000	3.012000
## 92	1.852014	5.959449
## 93	1.853283	5.865889
## 94	1.864022	5.945441
## 95	1.883205	3.184230
## 96	1.885000	3.075000
## 97	1.889000	6.383000
## 98	1.896000	6.885000
## 99	1.944000	6.280000
## 100	1.981000	6.784000
## 101	1.990000	5.465000
## 102	2.004000	6.743000
## 103	2.010000	6.500000
## 104	2.020000	6.278000
## 105	2.026000	6.721000
## 106	2.029000	6.030000
## 107	2.031000	5.921000
## 108	2.081000	2.942000
## 109	2.086000	6.942000
## 110	2.091000	5.818000
## 111	2.110000	7.162000
## 112	2.136727	5.219097
## 113	2.151000	5.983000
## 114	2.175000	5.547000
## 115	2.192000	6.941000

## 116	2.211000	6.358000
## 117	2.240930	6.078350
## 118	2.273000	7.555000
## 119	2.273169	4.695876
## 120	2.321000	7.159000
## 121	2.325000	5.844000
## 122	2.328000	7.040000
## 123	2.344000	6.251000
## 124	2.348000	6.608000
## 125	2.350962	6.166562
## 126	2.363000	7.458000
## 127	2.374000	6.159000
## 128	2.384585	5.251170
## 129	2.393171	5.301390
## 130	2.395000	6.955000
## 131	2.397000	6.372000
## 132	2.415000	5.948000
## 133	2.427000	7.626000
## 134	2.462000	7.373000
## 135	2.469000	6.500000
## 136	2.475000	6.461000
## 137	2.496000	6.292000
## 138	2.569000	5.906000
## 139	2.578281	5.983878
## 140	2.618000	6.358000
## 141	2.623000	7.247000
## 142	2.629064	6.950247
## 143	2.655901	5.357909
## 144	2.660823	7.002555
## 145	2.667000	6.590000
## 146	2.670537	7.002555
## 147	2.711000	6.686000
## 148	2.729000	8.234000
## 149	2.747000	7.485000
## 150	2.748000	7.148000
## 151	2.791000	6.628000
## 152	2.804000	6.828000
## 153	2.814000	6.208000
## 154	2.830000	7.669000
## 155	2.837000	6.827000
## 156	2.839000	6.752000
## 157	2.859614	5.069770
## 158	2.889000	7.503000
## 159	2.890000	5.376000
## 160	2.917000	6.794000
## 161	3.000000	3.866000
## 162	3.018000	5.819000
## 163	3.142565	6.934332
## 164	3.149000	6.319000
## 165	3.163000	4.778000
## 166	3.173000	6.613000
## 167	3.186000	6.547000
## 168	3.215000	6.018000
## 169	3.237000	6.885000
## 170	3.241013	6.768236
## 171	3.303000	6.205000
## 172	3.304000	6.553000
## 173	3.320000	4.530000

## 174	3.335000	7.632000
## 175	3.470000	6.800000
## 176	3.491000	7.220000
## 177	3.496000	5.300000
## 178	3.519000	5.269000
## 179	3.563000	6.847000
## 180	3.735000	6.863000
## 181	3.795000	7.938000
## 182	3.821000	8.187000
## 183	3.823000	6.242000
## 184	3.843961	6.629390
## 185	3.851000	7.300000
## 186	3.867000	6.483000
## 187	3.917000	7.029000
## 188	3.921027	6.622652
## 189	3.930000	7.646000
## 190	3.978000	6.792000
## 191	3.983000	6.970000
## 192	3.983665	6.640794
## 193	4.005000	5.921000
## 194	4.080936	6.607081
## 195	4.089000	6.391000
## 196	4.159000	6.880000
## 197	4.171000	6.085000
## 198	4.257000	6.717000
## 199	4.266000	5.653000
## 200	4.308000	7.115000
## 201	4.354710	6.724125
## 202	4.359060	5.603609
## 203	4.387000	6.996000
## 204	4.398000	6.354000
## 205	4.399000	6.112000
## 206	4.418000	7.691000
## 207	4.457000	6.647000
## 208	4.463000	5.647000
## 209	4.469000	6.721000
## 210	4.585000	6.936000
## 211	4.601289	6.609096
## 212	4.601463	6.609096
## 213	4.620300	6.702820
## 214	4.643000	7.282000
## 215	4.644000	6.315000
## 216	4.644854	6.414706
## 217	4.684000	6.246000
## 218	4.726000	6.725000
## 219	4.772000	6.248000
## 220	4.844171	6.563645
## 221	4.973000	6.282000
## 222	4.978662	6.458448
## 223	5.078000	7.003000
## 224	5.237000	6.364000
## 225	5.304000	6.708000
## 226	5.956000	7.004000
## 227	5.978000	5.814000
## 228	6.156000	6.080000
## 229	6.255000	6.250000
## 230	6.312000	7.250000
## 231	6.820000	7.530000

```
# Compare minimum fertility rates in 1960 vs. minimum fertility rates in 2021
aggregate(fertility_rates$"1960" ~ fertility_rates$"2021", FUN = min)
```

##	fertility_rates\$"2021"	fertility_rates\$"1960"
## 1	0.772000	5.067000
## 2	0.808000	5.949000
## 3	0.907000	4.796000
## 4	1.005000	5.162000
## 5	1.088000	4.933000
## 6	1.120000	5.760000
## 7	1.140000	3.620000
## 8	1.160000	2.240000
## 9	1.164000	4.451000
## 10	1.180000	4.820000
## 11	1.190000	2.860000
## 12	1.250000	2.400000
## 13	1.300000	2.000000
## 14	1.321000	3.512000
## 15	1.330000	2.980000
## 16	1.331000	6.248000
## 17	1.340000	2.560000
## 18	1.350000	3.907000
## 19	1.352000	5.580000
## 20	1.380000	2.290000
## 21	1.383908	4.801000
## 22	1.389000	4.818000
## 23	1.390000	2.230000
## 24	1.396865	4.378614
## 25	1.399000	6.967000
## 26	1.410000	6.167000
## 27	1.413000	6.704000
## 28	1.430000	3.811000
## 29	1.442000	4.129000
## 30	1.457000	2.270000
## 31	1.460000	2.720000
## 32	1.480000	2.113000
## 33	1.483000	2.670000
## 34	1.488552	2.897990
## 35	1.489433	4.561606
## 36	1.493000	2.520000
## 37	1.498219	4.531774
## 38	1.504510	2.605864
## 39	1.516846	4.864229
## 40	1.520000	2.440000
## 41	1.520288	2.571186
## 42	1.520442	4.841982
## 43	1.522000	6.359000
## 44	1.531000	7.169000
## 45	1.533000	6.712000
## 46	1.537000	4.697000
## 47	1.544788	3.019437
## 48	1.550000	2.850000
## 49	1.550993	2.491059
## 50	1.560000	2.690000
## 51	1.564000	2.875000
## 52	1.570000	1.940000
## 53	1.575000	4.786000
## 54	1.580000	2.310000

## 55	1.581000	4.202000
## 56	1.589351	3.285589
## 57	1.590000	2.020000
## 58	1.595000	6.866000
## 59	1.600000	2.540000
## 60	1.610000	1.980000
## 61	1.620000	2.232000
## 62	1.626000	5.345000
## 63	1.633000	4.333000
## 64	1.640000	2.185000
## 65	1.640018	3.668255
## 66	1.641000	6.061000
## 67	1.664000	3.654000
## 68	1.664522	5.727913
## 69	1.669000	5.790000
## 70	1.670000	2.170000
## 71	1.692000	6.804000
## 72	1.693061	2.831429
## 73	1.699000	5.888000
## 74	1.700000	3.453000
## 75	1.717000	6.735000
## 76	1.720000	2.570000
## 77	1.750000	3.498000
## 78	1.778000	6.836000
## 79	1.797000	7.286000
## 80	1.800000	2.340000
## 81	1.801000	6.647000
## 82	1.803000	6.407000
## 83	1.806000	3.328000
## 84	1.809000	3.568000
## 85	1.811000	7.152000
## 86	1.820000	4.290000
## 87	1.822000	6.763000
## 88	1.824446	4.970095
## 89	1.830000	2.090000
## 90	1.835001	3.103683
## 91	1.848000	3.012000
## 92	1.852014	5.959449
## 93	1.853283	5.865889
## 94	1.864022	5.945441
## 95	1.883205	3.184230
## 96	1.885000	3.075000
## 97	1.889000	6.383000
## 98	1.896000	6.885000
## 99	1.944000	6.280000
## 100	1.981000	6.784000
## 101	1.990000	5.465000
## 102	2.004000	6.743000
## 103	2.010000	5.445000
## 104	2.020000	6.278000
## 105	2.026000	6.721000
## 106	2.029000	6.030000
## 107	2.031000	5.921000
## 108	2.081000	2.942000
## 109	2.086000	6.942000
## 110	2.091000	5.818000
## 111	2.110000	7.162000
## 112	2.136727	5.219097



## 113	2.151000	5.983000
## 114	2.175000	5.547000
## 115	2.192000	6.941000
## 116	2.211000	6.358000
## 117	2.240930	6.078350
## 118	2.273000	7.555000
## 119	2.273169	4.695876
## 120	2.321000	7.159000
## 121	2.325000	5.844000
## 122	2.328000	7.040000
## 123	2.344000	6.251000
## 124	2.348000	6.608000
## 125	2.350962	6.166562
## 126	2.363000	7.458000
## 127	2.374000	6.159000
## 128	2.384585	5.251170
## 129	2.393171	5.301390
## 130	2.395000	6.955000
## 131	2.397000	6.372000
## 132	2.415000	5.948000
## 133	2.427000	7.626000
## 134	2.462000	7.373000
## 135	2.469000	6.500000
## 136	2.475000	6.461000
## 137	2.496000	6.292000
## 138	2.569000	5.906000
## 139	2.578281	5.983878
## 140	2.618000	6.358000
## 141	2.623000	7.247000
## 142	2.629064	6.950247
## 143	2.655901	5.357909
## 144	2.660823	7.002555
## 145	2.667000	6.590000
## 146	2.670537	7.002555
## 147	2.711000	6.686000
## 148	2.729000	8.234000
## 149	2.747000	7.485000
## 150	2.748000	7.148000
## 151	2.791000	6.628000
## 152	2.804000	6.828000
## 153	2.814000	6.208000
## 154	2.830000	7.669000
## 155	2.837000	6.827000
## 156	2.839000	6.752000
## 157	2.859614	5.069770
## 158	2.889000	7.503000
## 159	2.890000	5.376000
## 160	2.917000	6.794000
## 161	3.000000	3.866000
## 162	3.018000	5.819000
## 163	3.142565	6.934332
## 164	3.149000	6.319000
## 165	3.163000	4.778000
## 166	3.173000	6.613000
## 167	3.186000	6.547000
## 168	3.215000	6.018000
## 169	3.237000	6.885000
## 170	3.241013	6.768236

## 171	3.303000	6.205000
## 172	3.304000	6.553000
## 173	3.320000	4.530000
## 174	3.335000	7.632000
## 175	3.470000	6.800000
## 176	3.491000	4.422000
## 177	3.496000	5.300000
## 178	3.519000	5.269000
## 179	3.563000	6.847000
## 180	3.735000	6.863000
## 181	3.795000	7.938000
## 182	3.821000	8.187000
## 183	3.823000	6.242000
## 184	3.843961	6.629390
## 185	3.851000	7.300000
## 186	3.867000	6.483000
## 187	3.917000	7.029000
## 188	3.921027	6.622652
## 189	3.930000	7.646000
## 190	3.978000	6.175000
## 191	3.983000	6.970000
## 192	3.983665	6.640794
## 193	4.005000	5.921000
## 194	4.080936	6.607081
## 195	4.089000	6.391000
## 196	4.159000	6.880000
## 197	4.171000	6.085000
## 198	4.257000	6.717000
## 199	4.266000	5.653000
## 200	4.308000	7.115000
## 201	4.354710	6.724125
## 202	4.359060	5.603609
## 203	4.387000	6.996000
## 204	4.398000	6.354000
## 205	4.399000	6.112000
## 206	4.418000	7.691000
## 207	4.457000	6.647000
## 208	4.463000	5.647000
## 209	4.469000	6.721000
## 210	4.585000	6.936000
## 211	4.601289	6.609096
## 212	4.601463	6.609096
## 213	4.620300	6.702820
## 214	4.643000	7.282000
## 215	4.644000	6.315000
## 216	4.644854	6.414706
## 217	4.684000	6.246000
## 218	4.726000	6.725000
## 219	4.772000	6.248000
## 220	4.844171	6.563645
## 221	4.973000	6.282000
## 222	4.978662	6.458448
## 223	5.078000	7.003000
## 224	5.237000	6.364000
## 225	5.304000	6.708000
## 226	5.956000	7.004000
## 227	5.978000	5.814000
## 228	6.156000	6.080000

```
## 229          6.255000          6.250000
## 230          6.312000          7.250000
## 231          6.820000          7.530000

# Find Average Total Fertility rate by Country Name in 1960 vs. 2021.
# Assign the result to avg_fertility_rate.
avg_fertility_rate <- aggregate(fertility_rates$"1960"
                               ~ fertility_rates$"2021"
                               + fertility_rates$"Country Name",
                               FUN = mean)
```

## Step 5: Create figures

Figure 1

```
# Create a scatter plot of the data to find general pattern of fertility rates
ggplot(avg_fertility_rate, aes(x = `fertility_rates$"2021"`, y = `fertility_rates$"1960"`) +
  geom_point() +
  geom_smooth(method = "lm", se = FALSE) +
  xlab("Average Total Fertility Rate in 2021") +
  ylab("Average Total Fertility Rate in 1960") +
  ggtitle("Average Total Fertility Rate by Country (1960 vs. 2021)")

## `geom_smooth()` using formula = 'y ~ x'
```

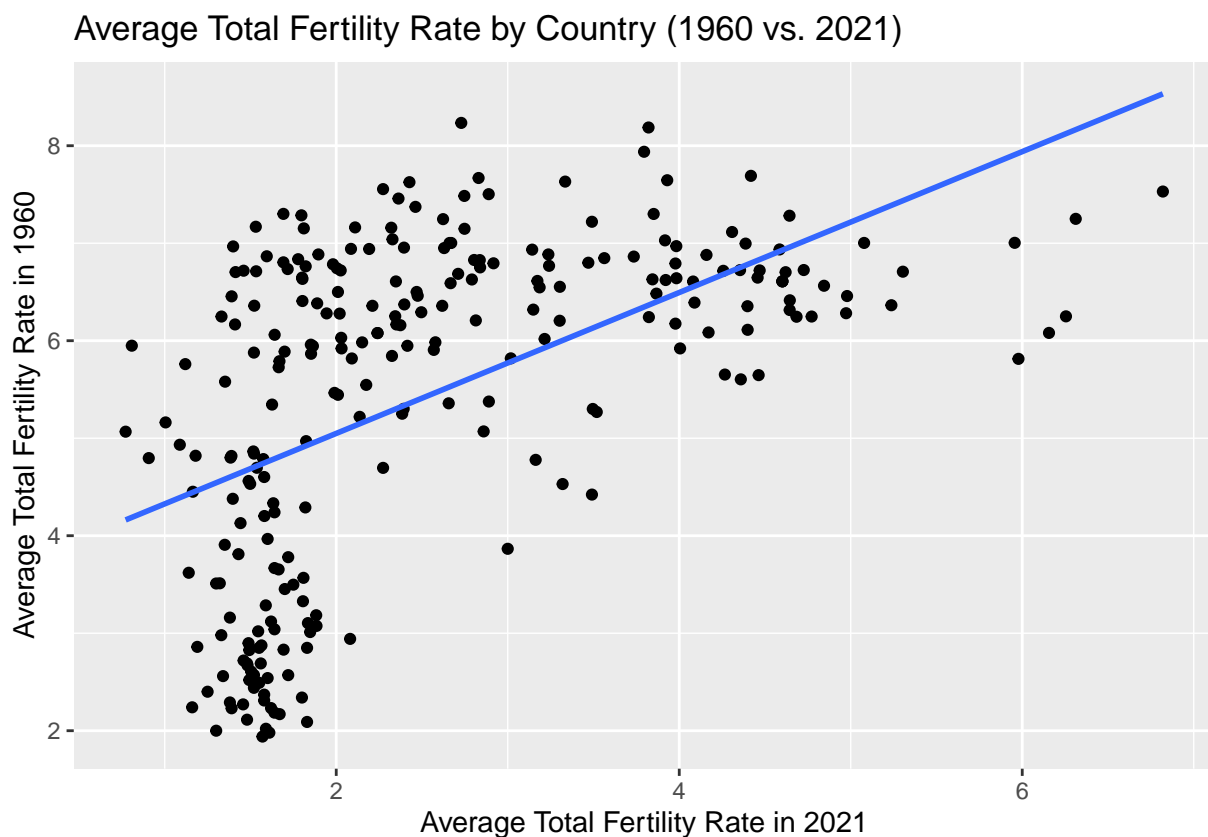


Figure 2

```
# Find unique country names in fertility_rates table
country_names <- unique(fertility_rates$`Country Name`)
sorted_country_names <- sort(country_names)
sorted_country_names
```

```

## [1] "Afghanistan"
## [2] "Africa Eastern and Southern"
## [3] "Africa Western and Central"
## [4] "Albania"
## [5] "Algeria"
## [6] "American Samoa"
## [7] "Andorra"
## [8] "Angola"
## [9] "Antigua and Barbuda"
## [10] "Arab World"
## [11] "Argentina"
## [12] "Armenia"
## [13] "Aruba"
## [14] "Australia"
## [15] "Austria"
## [16] "Azerbaijan"
## [17] "Bahamas, The"
## [18] "Bahrain"
## [19] "Bangladesh"
## [20] "Barbados"
## [21] "Belarus"
## [22] "Belgium"
## [23] "Belize"
## [24] "Benin"
## [25] "Bermuda"
## [26] "Bhutan"
## [27] "Bolivia"
## [28] "Bosnia and Herzegovina"
## [29] "Botswana"
## [30] "Brazil"
## [31] "British Virgin Islands"
## [32] "Brunei Darussalam"
## [33] "Bulgaria"
## [34] "Burkina Faso"
## [35] "Burundi"
## [36] "Cabo Verde"
## [37] "Cambodia"
## [38] "Cameroon"
## [39] "Canada"
## [40] "Caribbean small states"
## [41] "Cayman Islands"
## [42] "Central African Republic"
## [43] "Central Europe and the Baltics"
## [44] "Chad"
## [45] "Channel Islands"
## [46] "Chile"
## [47] "China"
## [48] "Colombia"
## [49] "Comoros"
## [50] "Congo, Dem. Rep."
## [51] "Congo, Rep."
## [52] "Costa Rica"
## [53] "Cote d'Ivoire"
## [54] "Croatia"
## [55] "Cuba"
## [56] "Curacao"
## [57] "Cyprus"
## [58] "Czechia"

```

## [59] "Denmark"  
 ## [60] "Djibouti"  
 ## [61] "Dominica"  
 ## [62] "Dominican Republic"  
 ## [63] "Early-demographic dividend"  
 ## [64] "East Asia & Pacific"  
 ## [65] "East Asia & Pacific (excluding high income)"  
 ## [66] "East Asia & Pacific (IDA & IBRD countries)"  
 ## [67] "Ecuador"  
 ## [68] "Egypt, Arab Rep."  
 ## [69] "El Salvador"  
 ## [70] "Equatorial Guinea"  
 ## [71] "Eritrea"  
 ## [72] "Estonia"  
 ## [73] "Eswatini"  
 ## [74] "Ethiopia"  
 ## [75] "Euro area"  
 ## [76] "Europe & Central Asia"  
 ## [77] "Europe & Central Asia (excluding high income)"  
 ## [78] "Europe & Central Asia (IDA & IBRD countries)"  
 ## [79] "European Union"  
 ## [80] "Faroe Islands"  
 ## [81] "Fiji"  
 ## [82] "Finland"  
 ## [83] "Fragile and conflict affected situations"  
 ## [84] "France"  
 ## [85] "French Polynesia"  
 ## [86] "Gabon"  
 ## [87] "Gambia, The"  
 ## [88] "Georgia"  
 ## [89] "Germany"  
 ## [90] "Ghana"  
 ## [91] "Gibraltar"  
 ## [92] "Greece"  
 ## [93] "Greenland"  
 ## [94] "Grenada"  
 ## [95] "Guam"  
 ## [96] "Guatemala"  
 ## [97] "Guinea"  
 ## [98] "Guinea-Bissau"  
 ## [99] "Guyana"  
 ## [100] "Haiti"  
 ## [101] "Heavily indebted poor countries (HIPC)"  
 ## [102] "High income"  
 ## [103] "Honduras"  
 ## [104] "Hong Kong SAR, China"  
 ## [105] "Hungary"  
 ## [106] "IBRD only"  
 ## [107] "Iceland"  
 ## [108] "IDA & IBRD total"  
 ## [109] "IDA blend"  
 ## [110] "IDA only"  
 ## [111] "IDA total"  
 ## [112] "India"  
 ## [113] "Indonesia"  
 ## [114] "Iran, Islamic Rep."  
 ## [115] "Iraq"  
 ## [116] "Ireland"

## [117] "Isle of Man"  
 ## [118] "Israel"  
 ## [119] "Italy"  
 ## [120] "Jamaica"  
 ## [121] "Japan"  
 ## [122] "Jordan"  
 ## [123] "Kazakhstan"  
 ## [124] "Kenya"  
 ## [125] "Kiribati"  
 ## [126] "Korea, Dem. People's Rep."  
 ## [127] "Korea, Rep."  
 ## [128] "Kosovo"  
 ## [129] "Kuwait"  
 ## [130] "Kyrgyz Republic"  
 ## [131] "Lao PDR"  
 ## [132] "Late-demographic dividend"  
 ## [133] "Latin America & Caribbean"  
 ## [134] "Latin America & Caribbean (excluding high income)"  
 ## [135] "Latin America & the Caribbean (IDA & IBRD countries)"  
 ## [136] "Latvia"  
 ## [137] "Least developed countries: UN classification"  
 ## [138] "Lebanon"  
 ## [139] "Lesotho"  
 ## [140] "Liberia"  
 ## [141] "Libya"  
 ## [142] "Liechtenstein"  
 ## [143] "Lithuania"  
 ## [144] "Low & middle income"  
 ## [145] "Low income"  
 ## [146] "Lower middle income"  
 ## [147] "Luxembourg"  
 ## [148] "Macao SAR, China"  
 ## [149] "Madagascar"  
 ## [150] "Malawi"  
 ## [151] "Malaysia"  
 ## [152] "Maldives"  
 ## [153] "Mali"  
 ## [154] "Malta"  
 ## [155] "Marshall Islands"  
 ## [156] "Mauritania"  
 ## [157] "Mauritius"  
 ## [158] "Mexico"  
 ## [159] "Micronesia, Fed. Sts."  
 ## [160] "Middle East & North Africa"  
 ## [161] "Middle East & North Africa (excluding high income)"  
 ## [162] "Middle East & North Africa (IDA & IBRD countries)"  
 ## [163] "Middle income"  
 ## [164] "Moldova"  
 ## [165] "Monaco"  
 ## [166] "Mongolia"  
 ## [167] "Montenegro"  
 ## [168] "Morocco"  
 ## [169] "Mozambique"  
 ## [170] "Myanmar"  
 ## [171] "Namibia"  
 ## [172] "Nauru"  
 ## [173] "Nepal"  
 ## [174] "Netherlands"

## [175] "New Caledonia"  
 ## [176] "New Zealand"  
 ## [177] "Nicaragua"  
 ## [178] "Niger"  
 ## [179] "Nigeria"  
 ## [180] "North America"  
 ## [181] "North Macedonia"  
 ## [182] "Northern Mariana Islands"  
 ## [183] "Norway"  
 ## [184] "Not classified"  
 ## [185] "OECD members"  
 ## [186] "Oman"  
 ## [187] "Other small states"  
 ## [188] "Pacific island small states"  
 ## [189] "Pakistan"  
 ## [190] "Palau"  
 ## [191] "Panama"  
 ## [192] "Papua New Guinea"  
 ## [193] "Paraguay"  
 ## [194] "Peru"  
 ## [195] "Philippines"  
 ## [196] "Poland"  
 ## [197] "Portugal"  
 ## [198] "Post-demographic dividend"  
 ## [199] "Pre-demographic dividend"  
 ## [200] "Puerto Rico"  
 ## [201] "Qatar"  
 ## [202] "Romania"  
 ## [203] "Russian Federation"  
 ## [204] "Rwanda"  
 ## [205] "Samoa"  
 ## [206] "San Marino"  
 ## [207] "Sao Tome and Principe"  
 ## [208] "Saudi Arabia"  
 ## [209] "Senegal"  
 ## [210] "Serbia"  
 ## [211] "Seychelles"  
 ## [212] "Sierra Leone"  
 ## [213] "Singapore"  
 ## [214] "Sint Maarten (Dutch part)"  
 ## [215] "Slovak Republic"  
 ## [216] "Slovenia"  
 ## [217] "Small states"  
 ## [218] "Solomon Islands"  
 ## [219] "Somalia"  
 ## [220] "South Africa"  
 ## [221] "South Asia"  
 ## [222] "South Asia (IDA & IBRD)"  
 ## [223] "South Sudan"  
 ## [224] "Spain"  
 ## [225] "Sri Lanka"  
 ## [226] "St. Kitts and Nevis"  
 ## [227] "St. Lucia"  
 ## [228] "St. Martin (French part)"  
 ## [229] "St. Vincent and the Grenadines"  
 ## [230] "Sub-Saharan Africa"  
 ## [231] "Sub-Saharan Africa (excluding high income)"  
 ## [232] "Sub-Saharan Africa (IDA & IBRD countries)"

```
## [233] "Sudan"
## [234] "Suriname"
## [235] "Sweden"
## [236] "Switzerland"
## [237] "Syrian Arab Republic"
## [238] "Tajikistan"
## [239] "Tanzania"
## [240] "Thailand"
## [241] "Timor-Leste"
## [242] "Togo"
## [243] "Tonga"
## [244] "Trinidad and Tobago"
## [245] "Tunisia"
## [246] "Turkiye"
## [247] "Turkmenistan"
## [248] "Turks and Caicos Islands"
## [249] "Tuvalu"
## [250] "Uganda"
## [251] "Ukraine"
## [252] "United Arab Emirates"
## [253] "United Kingdom"
## [254] "United States"
## [255] "Upper middle income"
## [256] "Uruguay"
## [257] "Uzbekistan"
## [258] "Vanuatu"
## [259] "Venezuela, RB"
## [260] "Vietnam"
## [261] "Virgin Islands (U.S.)"
## [262] "West Bank and Gaza"
## [263] "World"
## [264] "Yemen, Rep."
## [265] "Zambia"
## [266] "Zimbabwe"
```

```
# Filter the dataset to include only European countries
```

```
european_countries <- c("Albania", "Andorra", "Austria", "Belarus", "Belgium",
  "Bosnia and Herzegovina", "Bulgaria", "Channel Islands",
  "Croatia", "Cyprus", "Czechia", "Denmark", "Estonia",
  "Faroe Islands", "Finland", "France", "Germany",
  "Gibraltar", "Greece", "Hungary", "Iceland", "Ireland",
  "Isle of Man", "Italy", "Latvia", "Liechtenstein",
  "Lithuania", "Luxembourg", "Malta", "Moldova",
  "Monaco", "Montenegro", "Netherlands",
  "North Macedonia", "Norway", "Poland",
  "Portugal", "Romania", "Russian Federation",
  "San Marino", "Serbia", "Slovakia", "Slovenia", "Spain",
  "Sweden", "Switzerland", "Ukraine", "United Kingdom",
  "Vatican City")
```

```
# Replace with the list of European countries
```

```
fertility_rates_europe <- fertility_rates %>%
  filter(`Country Name` %in% european_countries)
```

```
# Reshape the data from wide to long format
```

```
fertility_rates_long <- fertility_rates_europe %>%
  pivot_longer(cols = `1960`:`2021`,
    names_to = "Year",
```





Figure 3

```

# Filter the dataset to include only African countries
african_countries <- c("Angola", "Benin", "Burkina Faso", "Burundi", "Cabo Verde",

```

```

"Cameroon", "Central African Republic", "Chad", "Comoros",
"Congo, Dem. Rep.", "Congo, Rep.", "Cote d'Ivoire",
"Djibouti", "Egypt, Arab Rep.", "Equatorial Guinea",
"Eritrea", "Eswatini", "Ethiopia", "Gabon", "Gambia, The",
"Ghana", "Guinea", "Guinea-Bissau", "Kenya", "Lesotho",
"Liberia", "Libya", "Madagascar", "Malawi", "Mali",
"Mauritania", "Mauritius", "Morocco", "Mozambique",
"Namibia", "Niger", "Nigeria", "Rwanda",
"Sao Tome and Principe", "Senegal",
"Seychelles", "Sierra Leone", "Somalia", "South Africa",
"South Sudan", "Sudan", "Tanzania", "Togo", "Tunisia",
"Uganda", "Zambia", "Zimbabwe")

# Replace with the list of African countries
fertility_rates_africa <- fertility_rates %>%
  filter(`Country Name` %in% african_countries)

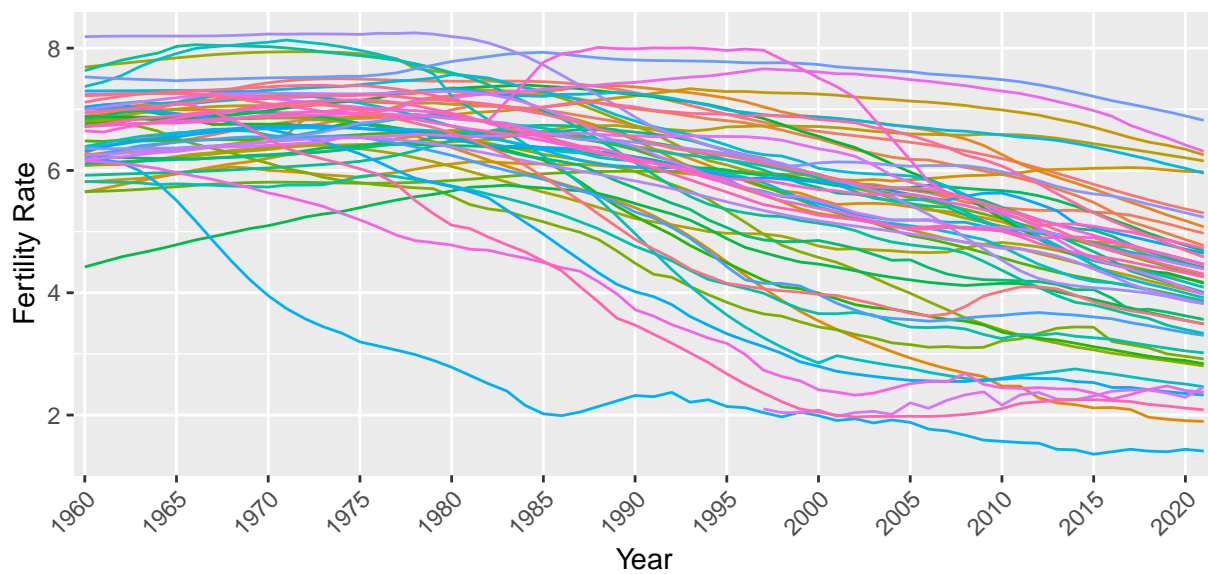
# Reshape the data from wide to long format
fertility_rates_long <- fertility_rates_africa %>%
  pivot_longer(cols = `1960`:`2021`,
    names_to = "Year",
    values_to = "Fertility_Rate")

# Create the plot with custom x-axis labels
p <- ggplot(fertility_rates_long,
  aes(x = Year,
    y = Fertility_Rate,
    color = `Country Name`,
    group = `Country Name`)) +
  geom_line() +
  xlab("Year") +
  ylab("Fertility Rate") +
  ggtitle("Average Total Fertility Rate in African Countries (1960-2021)") +
  scale_x_discrete(breaks = seq(1960, 2021, by = 5)) +
  theme(axis.text.x = element_text(angle = 45, hjust = 1),
    legend.position = "bottom") +
  guides(color = guide_legend(ncol = 3))

```

p

Average Total Fertility Rate in African Countries (1960–2021)



```
# Save the plot to a file with a resolution of 400 dpi
ggsave("Documents/data_analytics/fertility_rate_case_study/fertility_rates_africa.png",
  plot = p,
  width = 20,
  dpi = 1000)
```

```
## Saving 20 x 8 in image
```

Figure 4

```

# Filter the dataset to include only Asian countries
asian_countries <- c("Afghanistan", "Armenia", "Azerbaijan", "Bahrain", "Bangladesh",
  "Bhutan", "Brunei Darussalam", "Cambodia", "China", "Georgia",
  "Hong Kong SAR, China", "India", "Indonesia", "Iran, Islamic Rep.",
  "Iraq", "Israel", "Japan", "Jordan", "Kazakhstan",
  "Korea, Dem. People's Rep.", "Korea, Rep.", "Kuwait",
  "Kyrgyz Republic", "Lao PDR", "Lebanon",
  "Macao SAR, China", "Malaysia", "Maldives",
  "Mongolia", "Myanmar", "Nepal",
  "Oman", "Pakistan", "Palestine", "Philippines", "Qatar",
  "Russian Federation", "Saudi Arabia", "Singapore", "Sri Lanka",
  "Syrian Arab Republic", "Taiwan, China", "Tajikistan", "Thailand",
  "Timor-Leste", "Turkey", "Turkmenistan", "United Arab Emirates",
  "Uzbekistan", "Vietnam", "Yemen, Rep.")

# Replace with the list of Asian countries
fertility_rates_asia <- fertility_rates %>%
  filter(`Country Name` %in% asian_countries)

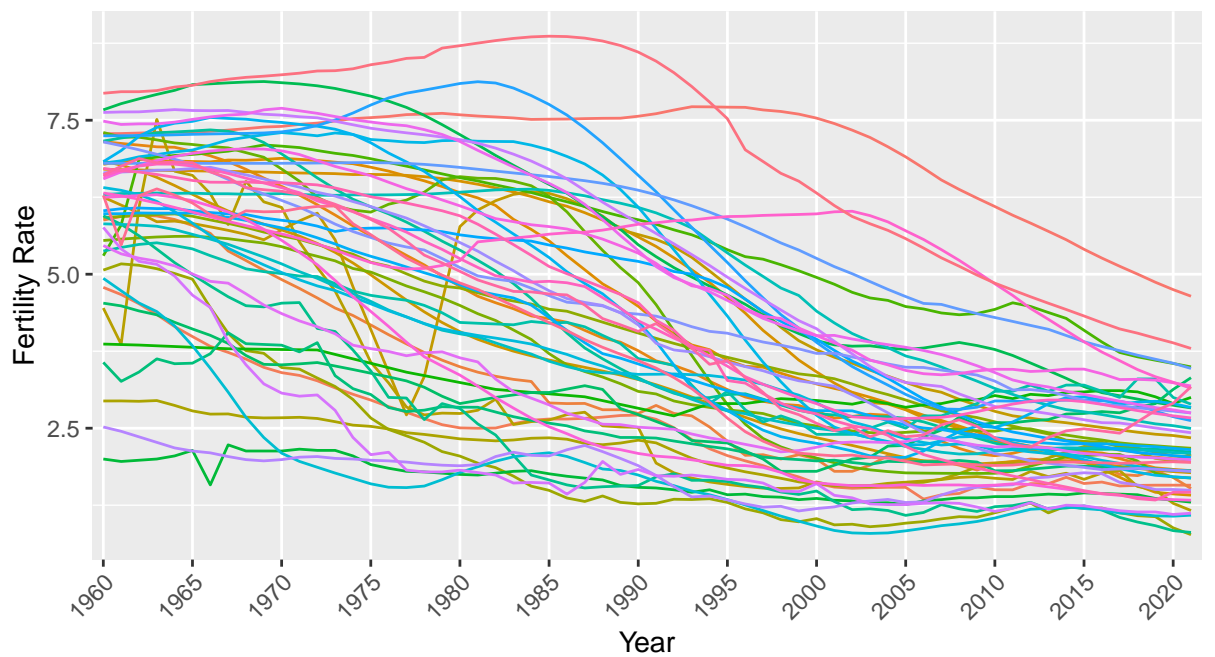
# Reshape the data from wide to long format
fertility_rates_long <- fertility_rates_asia %>%
  pivot_longer(cols = `1960`:`2021`,
    names_to = "Year",
    values_to = "Fertility_Rate")

# Create the plot with custom x-axis labels
p <- ggplot(fertility_rates_long,
  aes(x = Year,
    y = Fertility_Rate,
    color = `Country Name`,
    group = `Country Name`)) +
  geom_line() +
  xlab("Year") +
  ylab("Fertility Rate") +
  ggtitle("Average Total Fertility Rate in Asian Countries (1960-2021)") +
  scale_x_discrete(breaks = seq(1960, 2021, by = 5)) +
  theme(axis.text.x = element_text(angle = 45, hjust = 1),
    legend.position = "bottom") +
  guides(color = guide_legend(ncol = 3))

```

p

Average Total Fertility Rate in Asian Countries (1960–2021)



Afghanistan	Japan	Pakistan
Armenia	Jordan	Philippines
Azerbaijan	Kazakhstan	Qatar
Bahrain	Korea, Dem. People's Rep.	Russian Federation
Bangladesh	Korea, Rep.	Saudi Arabia
Bhutan	Kuwait	Singapore
Brunei Darussalam	Kyrgyz Republic	Sri Lanka
Cambodia	Lao PDR	Syrian Arab Republic
China	Lebanon	Tajikistan
Georgia	Macao SAR, China	Thailand
Hong Kong SAR, China	Malaysia	Timor-Leste
India	Maldives	Turkmenistan
Indonesia	Mongolia	United Arab Emirates
Iran, Islamic Rep.	Myanmar	Uzbekistan
Iraq	Nepal	Vietnam
Israel	Oman	Yemen, Rep.

```
# Save the plot to a file with a resolution of 400 dpi
ggsave("Documents/data_analytics/fertility_rate_case_study/fertility_rates_asia.png",
  plot = p,
  width = 10,
  dpi = 1000)
```

```
## Saving 10 x 8 in image
```

Figure 5

```
# Filter the dataset to include only North American countries
north_american_countries <- c("Antigua and Barbuda", "Bahamas, The", "Barbados",
```

```

      "Belize", "Canada", "Costa Rica", "Cuba", "Dominica",
      "Dominican Republic", "El Salvador", "Greenland",
      "Grenada", "Guatemala", "Haiti", "Honduras",
      "Jamaica", "Mexico", "Nicaragua", "Panama",
      "St. Kitts and Nevis", "St. Lucia",
      "St. Vincent and the Grenadines",
      "Trinidad and Tobago", "United States")

# Replace with the list of North American countries
fertility_rates_north_america <- fertility_rates %>%
  filter(`Country Name` %in% north_american_countries)

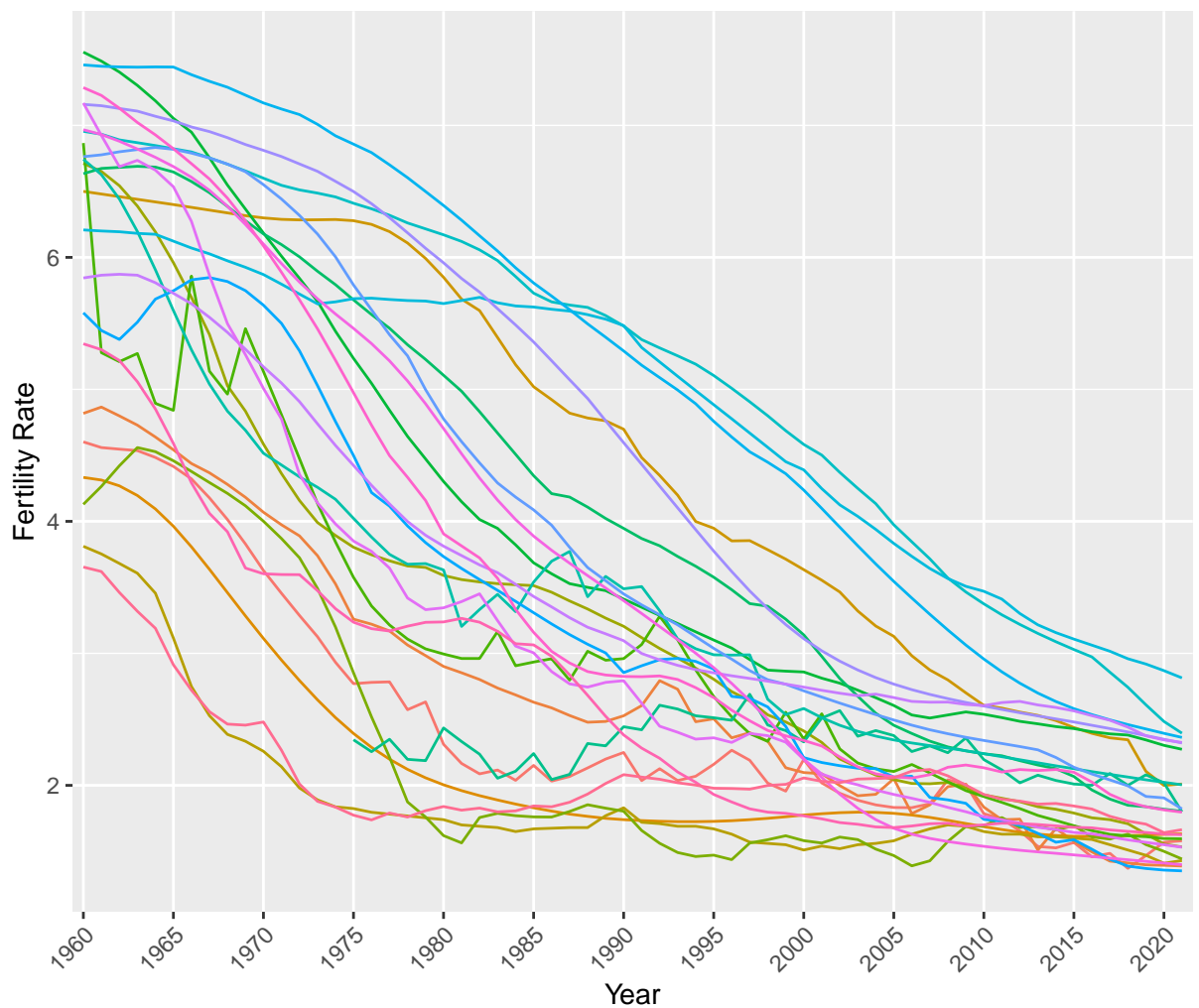
# Reshape the data from wide to long format
fertility_rates_long <- fertility_rates_north_america %>%
  pivot_longer(cols = `1960`:`2021`,
               names_to = "Year",
               values_to = "Fertility_Rate")

# Create the plot with custom x-axis labels
p <- ggplot(fertility_rates_long,
            aes(x = Year,
                y = Fertility_Rate,
                color = `Country Name`,
                group = `Country Name`)) +
  geom_line() +
  xlab("Year") +
  ylab("Fertility Rate") +
  ggtitle("Average Total Fertility Rate in North American Countries (1960-2021)") +
  scale_x_discrete(breaks = seq(1960, 2021, by = 5)) +
  theme(axis.text.x = element_text(angle = 45, hjust = 1),
        legend.position = "bottom") +
  guides(color = guide_legend(ncol = 3))

```

p

## Average Total Fertility Rate in North American Countries (1960–2021)



Antigua and Barbuda	Dominican Republic	Mexico
Bahamas, The	El Salvador	Nicaragua
Barbados	Greenland	Panama
Belize	Grenada	St. Kitts and Nevis
Canada	Guatemala	St. Lucia
Costa Rica	Haiti	St. Vincent and the Grenadines
Cuba	Honduras	Trinidad and Tobago
Dominica	Jamaica	United States

```
# Save the plot to a file with a resolution of 400 dpi
ggsave("Documents/data_analytics/fertility_rate_case_study/fertility_rates_north_america.png",
  plot = p,
  width = 10,
  dpi = 1000)
```

```
## Saving 10 x 8 in image
```

**Figure 6**

```
# Filter the dataset to include only South American countries
south_american_countries <- c("Argentina", "Bolivia", "Brazil", "Chile",
```

```

        "Colombia", "Ecuador", "Guyana", "Paraguay",
        "Peru", "Suriname", "Uruguay", "Venezuela")

# Replace with the list of South American countries
fertility_rates_south_america <- fertility_rates %>%
  filter(`Country Name` %in% south_american_countries)

# Reshape the data from wide to long format
fertility_rates_long <- fertility_rates_south_america %>%
  pivot_longer(cols = `1960`:`2021`,
               names_to = "Year",
               values_to = "Fertility_Rate")

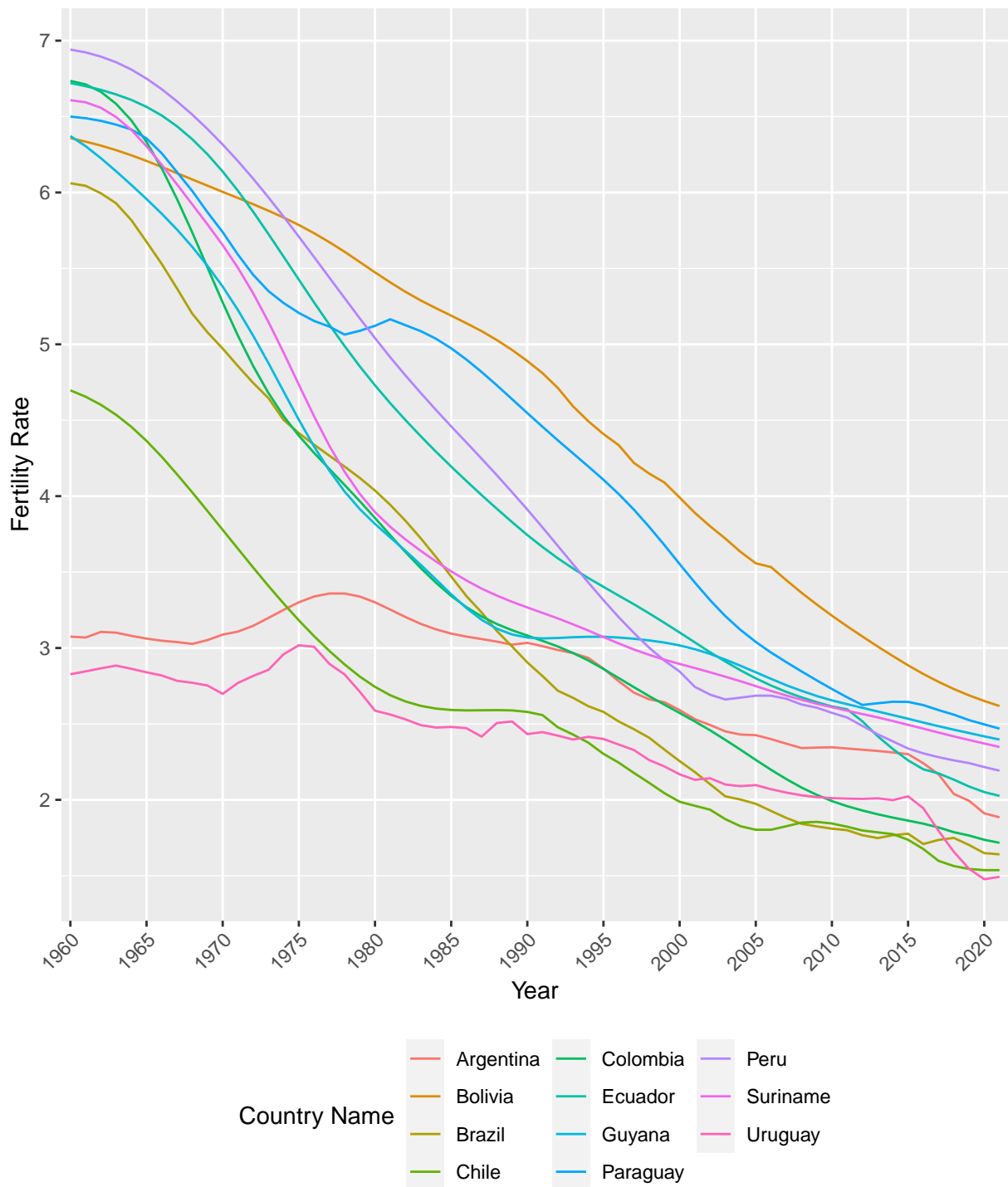
# Create the plot with custom x-axis labels
p <- ggplot(fertility_rates_long,
            aes(x = Year,
                y = Fertility_Rate,
                color = `Country Name`,
                group = `Country Name`)) +
  geom_line() +
  xlab("Year") +
  ylab("Fertility Rate") +
  ggtitle("Average Total Fertility Rate in South American Countries (1960-2021)") +
  scale_x_discrete(breaks = seq(1960, 2021, by = 5)) +
  theme(axis.text.x = element_text(angle = 45, hjust = 1),
        legend.position = "bottom") +
  guides(color = guide_legend(ncol = 3))

```

p



Average Total Fertility Rate in South American Countries (1960–2021)



```
# Save the plot to a file with a resolution of 400 dpi
ggsave("Documents/data_analytics/fertility_rate_case_study/fertility_rates_south_america.png",
  plot = p,
  width = 10,
  dpi = 1000)
```

## Saving 10 x 8 in image

Figure 7

```

# Filter the dataset to include only Oceanic countries
oceanic_countries <- c("Australia", "Fiji", "Kiribati", "Marshall Islands",
  "Micronesia, Fed. Sts.", "Nauru", "New Zealand", "Palau",
  "Papua New Guinea", "Samoa", "Solomon Islands", "Tonga",
  "Tuvalu", "Vanuatu")

# Replace with the list of Oceanic countries
fertility_rates_oceania <- fertility_rates %>%
  filter(`Country Name` %in% oceanic_countries)

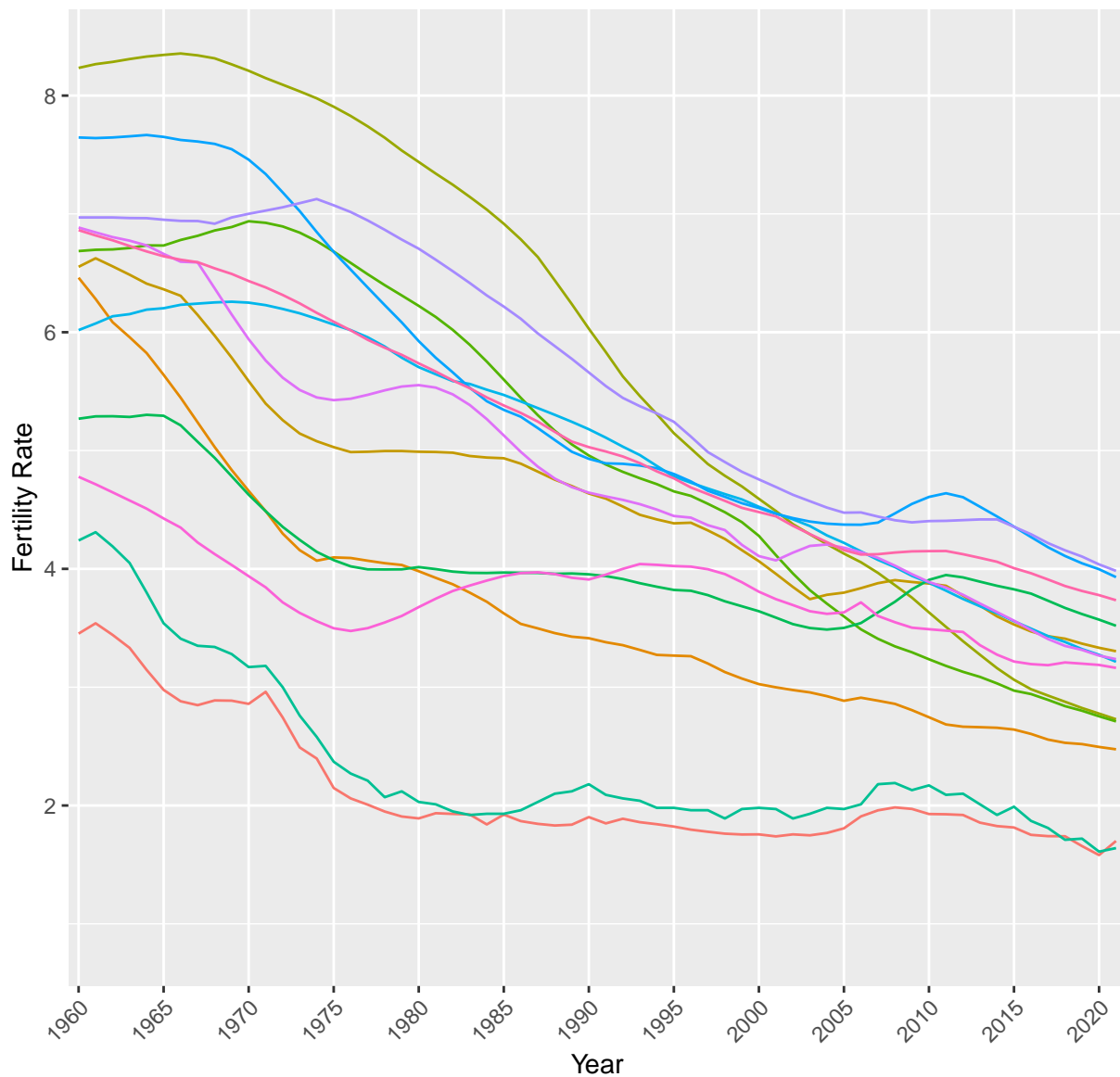
# Reshape the data from wide to long format
fertility_rates_long <- fertility_rates_oceania %>%
  pivot_longer(cols = `1960`:`2021`,
    names_to = "Year",
    values_to = "Fertility_Rate")

# Create the plot with custom x-axis labels
p <- ggplot(fertility_rates_long,
  aes(x = Year,
    y = Fertility_Rate,
    color = `Country Name`,
    group = `Country Name`)) +
  geom_line() +
  xlab("Year") +
  ylab("Fertility Rate") +
  ggtitle("Average Total Fertility Rate in Oceanic Countries (1960-2021)") +
  scale_x_discrete(breaks = seq(1960, 2021, by = 5)) +
  theme(axis.text.x = element_text(angle = 45, hjust = 1),
    legend.position = "bottom") +
  guides(color = guide_legend(ncol = 3))

```

p

## Average Total Fertility Rate in Oceanic Countries (1960–2021)



Country Name

Australia	Nauru	Solomon Islands
Fiji	New Zealand	Tonga
Kiribati	Palau	Tuvalu
Marshall Islands	Papua New Guinea	Vanuatu
Micronesia, Fed. Sts.	Samoa	

```
# Save the plot to a file with a resolution of 400 dpi
ggsave("Documents/data_analytics/fertility_rate_case_study/fertility_rates_oceania.png",
  plot = p,
  width = 10,
  dpi = 1000)
```

```
## Saving 10 x 8 in image
```

```
# Combine the data for all regions into one data frame
fertility_rates_all_regions <- bind_rows(
```

```

fertility_rates_africa %>% mutate(Region = "Africa"),
fertility_rates_asia %>% mutate(Region = "Asia"),
fertility_rates_europe %>% mutate(Region = "Europe"),
fertility_rates_north_america %>% mutate(Region = "North America"),
fertility_rates_oceania %>% mutate(Region = "Oceania"),
fertility_rates_south_america %>% mutate(Region = "South America")
)

# Reshape the data from wide to long format
fertility_rates_long <- fertility_rates_all_regions %>%
  pivot_longer(cols = `1960`:`2021`,
               names_to = "Year",
               values_to = "Fertility_Rate")

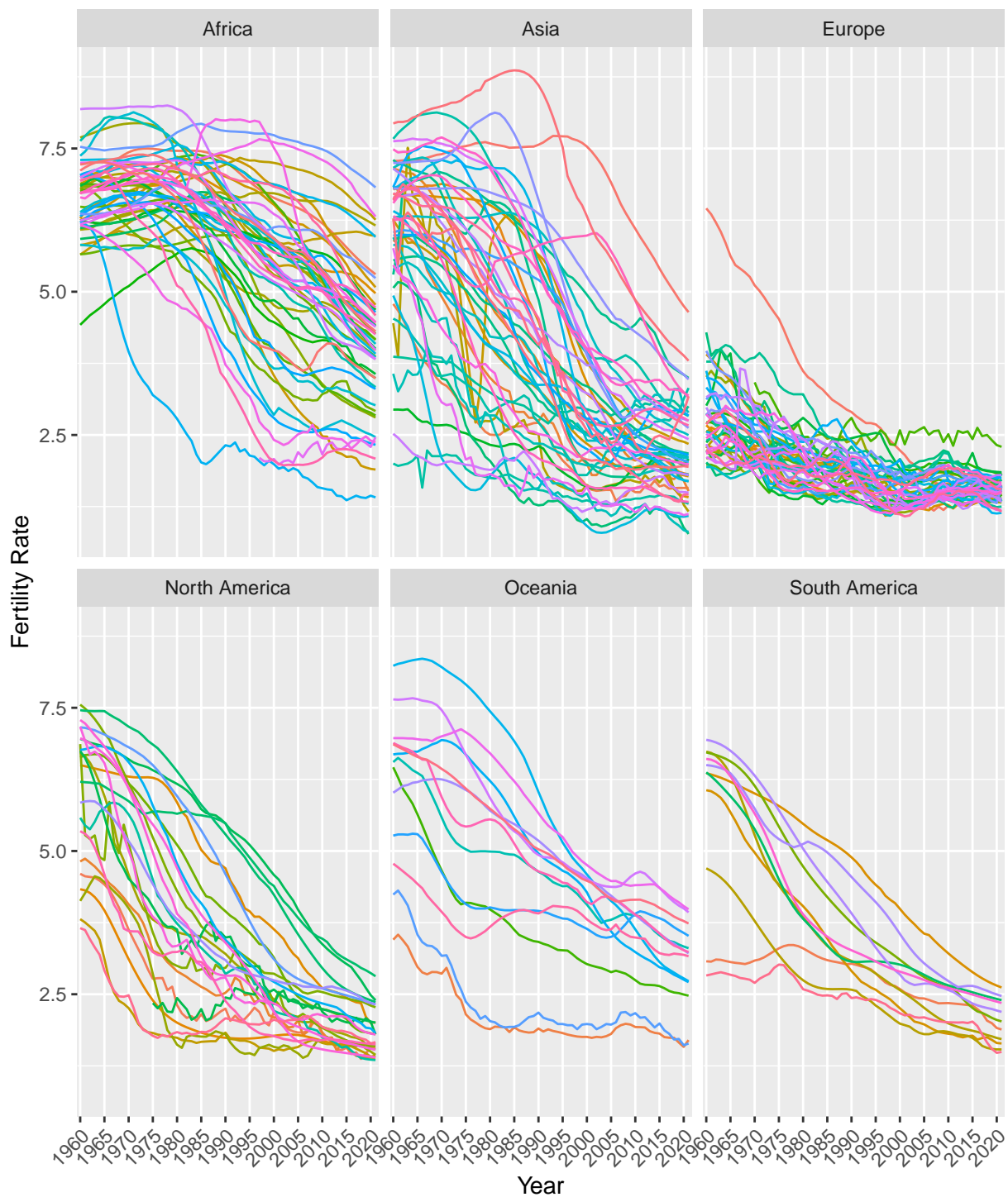
# Create the plot with custom x-axis labels and facets
p1 <- ggplot(fertility_rates_long,
             aes(x = Year,
                 y = Fertility_Rate,
                 color = `Country Name`,
                 group = `Country Name`)) +
  geom_line() +
  xlab("Year") +
  ylab("Fertility Rate") +
  ggtitle("Average Total Fertility Rate by Region (1960-2021)") +
  scale_x_discrete(breaks = seq(1960, 2021, by = 5)) +
  theme(axis.text.x = element_text(angle = 45, hjust = 1),
        legend.position = "none") +
  facet_wrap(~ Region)

p1

```

Average Total Fertility Rate by Geographic Region (1960-2021)

Average Total Fertility Rate by Region (1960–2021)



```
# Save the plot with the graphs to a file with a resolution of 400 dpi
ggsave("Documents/data_analytics/fertility_rate_case_study/fertility_rates_all_regions_graphs.png",
  plot = p1,
  width = 10,
  dpi = 1000)
```

```
## Saving 10 x 8 in image
```

```
# Create a separate plot for the legend
```

## Step 6: Export data, create Tableau dashboard

```
# Overall, it seems that many countries are experiencing a pronounced downward  
# trend in terms of average total fertility rate. To make this more clear,  
# let's export fertility_rates_long.csv to Tableau to create an interactive  
# dashboard.  
  
write.csv(fertility_rates_long,  
          "Documents/data_analytics/fertility_rate_case_study/fertility_rates_all_regions.csv",  
          row.names = FALSE)
```

## Step 7: Explore Tableau dashboard

- [Click here](#) to see the corresponding Tableau dashboard.